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ABSTRACT

Presented are guidelines for buying solar systems for the individual consumer. This is intended to help the consumer reduce many of the risks associated with the purchase of solar systems, particularly the risks of fraud and deception. Engineering terms associated with solar technology are presented and described to enable the consumer to discuss and evaluate systems on the market. The book does not attempt to describe all possible components of a solar system, but does treat main operating components. (Author/RE)

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# Buying Solar

ED173179

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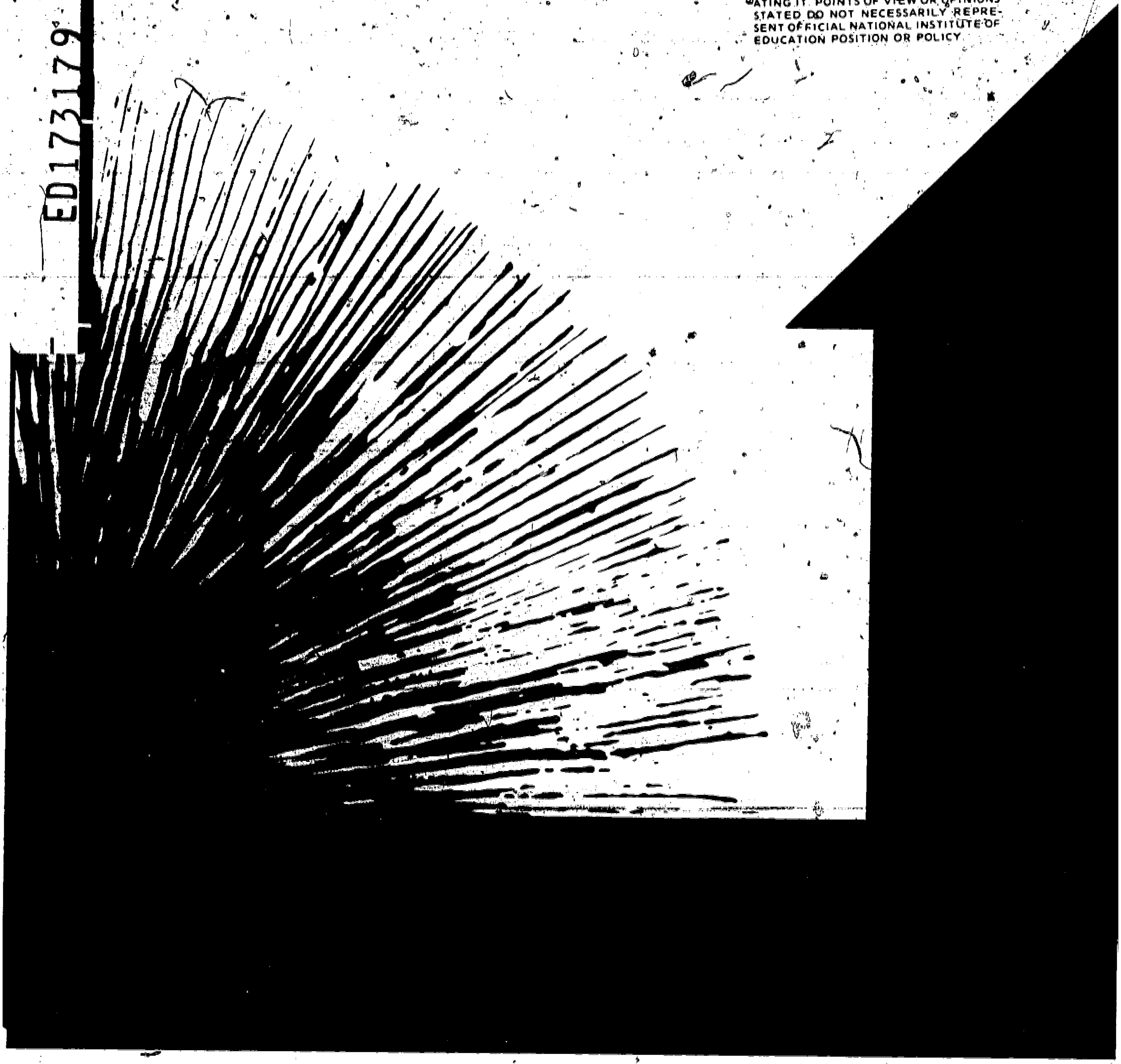

Federal Energy
Administration

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Solar energy is now in its infancy. Whether it grows to become a major factor in the Nation's energy supply will depend to a great extent on the Nation's buying public. The more informed consumers are about their choices in the marketplace, the greater the likelihood that solar manufacturers will compete over substance. When manufacturers compete in that fashion the base is laid for solid growth. The country needs to have this solid solar growth as well as growth in other alternate energy systems if our Nation is to become energy independent. For these reasons, and because of the consumer's own need for self-protection, it is important that the consumer receive as much accurate information as possible about solar systems. I am pleased that the Federal Energy Administration could work in partnership with the Office of Consumer Affairs to publish and distribute "Buying Solar."

Frank G. Zarb
Administrator
Federal Energy Administration

The dream of capturing energy directly from the sun is almost as old as man himself. Now that day has arrived, and perhaps no new energy technology has captured the imagination of the public as much as solar has. Beyond the excitement of the technology itself, there are other reasons why solar energy has become so popular. It is a nonpolluting, renewable form of energy that can lead to lower monthly bills; and it can provide the owner and the country a degree of independence from energy inflation and energy shortages.

All this enthusiasm, however, could vanish rapidly if solar systems do not live up to the public's expectations, if there are more disappointed buyers than satisfied owners of solar systems. This is the overall purpose of this publication--to give you, the reader, the information you need to protect yourself and to be an informed solar buyer.

Virginia Knauer
Virginia H. Knauer
Special Assistant to the President
for Consumer Affairs,
and Director, Office of Consumer Affairs,
Department of Health, Education, and Welfare

# Buying Solar

June 1976

This book is dedicated to the many solar pioneers across the country who are making the hope of solar energy a reality today.

By: Joe Dawson, Director, Public Affairs, Office of Consumer Affairs, Office of Synfuels, Health, Education, and Welfare.

## Solar Myths

Myth: It's a future technology.
Fact: It's here and working.
Myth: It only works down south.
Fact: It works in New England, too.
Myth: It's too expensive for the average homeowner.
Fact: Some solar systems are, some aren't.

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# CONTENTS

# FOREWORD

Solar energy* for your home is here. It may help you individually and it certainly will help the country collectively.

Whether it will help you individually in terms of producing real savings depends upon a number of factors, including where you live, the type of home you have or intend to build, the quality of insulation in your home, your present energy costs, and the type of solar system you intend to purchase.

The purpose of this book is to give you information on these five factors so that you, as an informed customer, can make decisions related to solar space heating and cooling and domestic water heating that are in your best interests. By doing so, you will not only be doing a service to yourself, but to your fellow citizens.

Those who are able to and do use solar systems will help our nation save its precious fossil fuels. As you know from reading the headlines, our domestic supplies of oil and gas are very limited. There are just not enough domestic supplies available to meet all our future needs. And when Mother Nature says *that's all*, that's all. The only way we can prevent or delay her from uttering those fatalistic words is by starting to conserve energy now, and using, where possible, sources of unlimited energy such as solar.

We won't have to worry about the sun running out of energy for another several billion years or so.

Besides being an almost infinite source of energy, solar has other advantages as well. When we use conventional sources to deliver energy to the home, we have serious problems to deal with, from the safe disposal of radioactive wastes to the pollution from fossil-fueled generating plants. With solar, we will still need these conventional sources of energy, but we won't need as much. That means that we can reduce our environmental and safety problems.

Further, owners of solar homes have extra protection against energy inflation and energy shortages. When utility costs go up, and they will go up, owners of solar homes may not have to face the possibility of considerably altering their lifestyles just to pay the utility bill. Cut-offs or curtailments of conventional fuels won't affect the owner of a solar home as much as others.

With all these advantages, one might wonder why solar power is not more developed. There are many reasons, but a primary one is economics. Until recently, it was just not economical for a home owner to install a solar unit when there were cheap sources of conventional energy around. But those days are gone forever, and now solar is becoming increasingly competitive, with electricity and oil. The present gas cost advantage over solar may change in the near future as a number of experts believe gas will triple in costs in the next few years. Too, gas is in such short supply that in many areas it is just not available for new customers. Some customers, in fact, are having their supplies curtailed.

Because solar energy has not been fully developed in the past, it poses some significant problems for the consumer in the present.

One main, obvious drawback is that the consumer has not had any experience in buying solar equipment. What questions does a potential buyer ask? How can he or she compare competing brands? How does a person get a unit repaired if it goes on the blink? What does a person do if his neighbor plants a tree and the tree throws a long shadow on the collector? Can the buyer trust the seller's claims for a particular solar unit? What happens to the unit when the owner goes on a vacation? How come there is no one under "solar" in the Yellow Pages? What happens if a vandal throws a rock at the collector?

The reader should know right away that this book won't give all the answers to all these questions or explain all systems, because in some cases, such as the important area of solar rights (your guaranteed right to access to the sun's rays without encroachment), there are no complete answers today. In other areas, such as measuring the efficiency of a collector, and evaluating different components, there are a few answers. But only an expert—a mechanical or an architectural engineer who has had background in solar—can give them to you. This is because what is a "smart" solar purchase for one consumer in one area may be a foolish buy for a consumer in another area.

This book does not explain to the consumer all the possible components in a system, nor all the systems available. Rather, it focuses on some of the main operating components such as the collector.

Some readers may be disappointed that observations are not given as to good or bad buys. The reader should remember that the Federal Government does not know all the systems available, and if several were selected as outstanding, it would be unfair to those whose products the government does not currently know about. The government should not be in a position of giving an unfair competitive advantage to any manufacturer. This policy, while certainly correct, unfortunately prevents our saluting many important solar pioneers and manufacturers.

*When solar energy is mentioned, the term is generally interpreted by the public to involve a solar collector which will provide energy to the home. Actually, solar energy has a broader meaning. It can involve photovoltaic energy the direct conversion of the sun's energy into electricity; bioconversion the utilization of agricultural or municipal wastes to provide fuel; ocean thermal providing power by harnessing the temperature difference between the surface waters and the ocean depths. wind harnessing wind energy to generate power; and solar thermal electric concentrating the sun's rays to obtain high temperatures and thus generate electric power

# SUN LANGUAGE

**ABSORBER, or ABSORBER PLATE:** A surface, usually blackened metal, in a solar collector which absorbs solar radiation.

**ABSORPTANCE:** The soaking up of heat in a solar collector. Measured as percent of total radiation available.

**ACTIVE SOLAR SYSTEM:** Any system that needs mechanical means such as motors, pumps, valves, etc., to operate.

**AMBIENT TEMPERATURE:** Another way of saying how cold or how hot it is outdoors.

**BIOCONVERSION:** Utilization of agricultural or municipal wastes to provide fuel.

**BRITISH THERMAL UNIT** (Btu): A unit of energy defined as the amount of energy required to heat one pound of water one degree Fahrenheit.

**COLLECTOR, or SOLAR COLLECTOR:** A device for receiving solar radiation and converting it to heat in a fluid.

**COLLECTOR EFFICIENCY:** The fraction of incoming radiation captured by the collector. If your system captures half of the incoming radiation, you have a system that is 50 percent efficient. Efficiency is the capability of a collector to capture Btu's under various climatic conditions. Efficiency varies according to outside temperatures, whether skies are clear or cloudy, whether it is windy or not, and, of course, the quality of the collector. There's no way a collector can be 100 percent efficient; that is, to capture all the Btu's that fall on the collector; 55 percent is good under desirable weather conditions.

**COLLECTOR TILT:** The angle measured from the horizontal at which a solar heat collector is tilted to face the sun for better performance.

**CONCENTRATOR:** Reflector or lens designed to focus a large amount of sunshine into a small area, thus increasing the temperature.

**CONDUCTIVITY:** The ease with which heat will flow through a material determined by the material's physical characteristics. Copper is an excellent conductor of heat; insulating materials are poor conductors.

**CONVECTION:** When two surfaces—one hot, the other cold—are separated by a thin layer of air, moving air currents (called convection currents) are established that carry heat from the hot to the cold surface.

**EMITTANCE:** A measure of the heat re-radiated back from the solar collector. Measured as fraction of the energy which would be radiated by a totally black surface at the same temperature.

**FLUID:** Any substance such as air, water, or antifreeze used to capture heat in the collector.

**GALVANIC CORROSION:** If you have this in your system, you have problems. This is caused when different metals are not isolated properly and a liquid comes in contact with both metals. The result is galvanic corrosion and repair bills.

**HELIOSTAT:** A mirror used to reflect the sun's rays into a solar collector or furnace.

**HYBRID SOLAR SYSTEM:** A system that uses both active and passive methods to operate (e.g., a solar system which uses pumps to heat and nocturnal cooling to cool).

**INSOLATION:** The rate of solar radiation received per unit area.

**KILOWATT:** One thousand watts of power; equal to about 1⅓ horsepower.

**KILOWATT-HOUR** (kWh). The amount of energy equivalent to 1 kilowatt of power being used for 1 hour 3,413 Btu.

**LANGLEY:** A unit of measurement of insolation. (One langley equals one gram-calorie per square centimeter.) The langley was named for American astronomer Samuel P. Langley.

**OCEAN THERMAL:** Providing power by harnessing the temperature differences between the surface waters and the ocean depths.

**PASSIVE SOLAR SYSTEM:** A system that uses gravity, heat flows, evaporation or other acts of Mother Naure to operate without mechanical devices to collect and transfer energy (i.e., south facing windows)

**PHOTOVOLTAIC:** Direct conversion of the sun's energy into electricity

**PYRANOMETER:** An instrument for measuring solar radiation

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**RADIATION:** Any object that is warmer than its surroundings radiates heat waves (similar to light waves, but invisible) and, thus, emits heat energy.

**RERADIATION:** After an object has received radiation or is otherwise heated, it often reradiates heat back. Generally speaking, matte black surfaces are good absorbers and emitters of thermal radiation while white and metallic surfaces are not.

**SELECTIVE SURFACE:** A special coating sometimes applied to the absorber plate in a solar collector. The selective surface absorbs most of the incoming solar energy and reradiates very little of it.

**SOLAR CELL:** A device, usually made of silicon, that converts sunlight directly into electrical energy.

**SOLAR CONSTANT:** The average amount of solar radiation reaching the earth's atmosphere per minute. This is just under 2 langleys, or 2 gram-calories per square centimeter. This is equivalent to 442.4 Btu/hr/ft$^2$, 1395 watts/m$^2$ or .1395 watts/cm$^2$.

**SOLAR RIGHTS:** An unresolved legal issue involving who owns the rights to the sun's rays.

**SUN TRACKING:** Following the sun with a solar collector to make the collector more effective.

**SYSTEM EFFICIENCY:** Btu's are lost from the time the sun's rays hit the collector to the moment they are used to heat the house or the water supply. The question is how many Btu's are used in comparison to the original number coming in. The answer is the efficiency of the whole system. **This is a very important consideration.**

**THERMOSYPHON:** The principle that makes water circulate automatically between a collector and a storage tank above it, gradually increasing its temperature.

## SUN TERMS

**K,** or **THERMAL CONDUCTIVITY:** A measure of the ability of a material to permit the flow of heat. It expresses the quantity of heat per hour that will pass through a one-square-foot chunk of inch-thick material when a 1° F temperature difference is maintained between its two surfaces. K is measured in Btu/(hr)(ft$^2$)(°F)/foot or inch.

**C:** A measure of the heat flow through a given thickness of material. If you know a material's K, to find its C, divide by the thickness; e.g., 3" thick insulation with a K of 0.30 has a C of 0.10. The lower the K or C, the higher the insulating value.

**U,** or **OVERALL COEFFICIENT OF HEAT TRANSMISSION:** A measure of the ability of a complete building section (such as a wall) to permit the flow of heat. U is the combined thermal conduction value of all the materials in a building section, plus air spaces and air films. The lower the U, the higher the insulating value. U Btu/(hr)(ft$^2$)(°F).

**R,** or **THERMAL RESISTANCE:** A measure of the ability of a substance to resist the flow of heat. R is simply the mathematical reciprocal of either C or U. Thus,

$$R = 1/C \text{ or } R = 1/U$$

Insulation products are typically characterized by their R values. Thus, a specification of R-11 means the insulation displays 11 resistance units. Clearly, the higher the R value, the better the insulating ability.

R is a simple common denominator for describing all types of insulation and all kinds of dwelling construction. For example, all insulation rated R 11 has the same insulation ability no matter what its material or thickness.

# ACKNOWLEDGMENTS

This book will give you many guidelines for buying solar systems, it should eliminate a good many risks, and it should help protect you against possible fraud and deception. It should familiarize you with engineering terms used to evaluate or describe solar products. But eventually, if you are a smart consumer, you will obtain the advice of an expert—a person who can look at your individual circumstance and give you advice tailored to your particular home.

This book could not have been written without the invaluable assistance of my colleagues at the various energy agencies, a number of solar businessmen, and the solar books mentioned in the Bibliography. The reader should know that I am not a solar expert, rather a consumer writer. What I attempted to do was to solicit advice from the most knowledgeable experts I could find on the topic, and then translate this technical information into usable language. I want to thank in particular Ray Fields and Bill Rice from the Energy Research and Development Administration, and Norm Lutkefedder at the Federal Energy Administration. Also, I owe a deep debt of gratitude to John K. Freeman, Deputy Assitant Administrator for Energy Projects, Federal Energy Administration, for offering to publish this book. Unfortunately, I cannot name all the businessmen who helped me with this book because to do so would give them a competitive advantage. They know who they are, however, and they know how grateful I am. I am at liberty to name Sheldon Butt, president of the Solar Energy Industries Association. Sheldon spent many hours going over the text, and his suggestions and comments were most helpful. The solar industry is fortunate to have such an outstanding professional at the helm. If the solar industry reaches its full potential, as I am sure it will, a great deal of credit will go to Sheldon. The mention of all these experts is not intended to shift any responsibility for the final product. If there are any errors, I am the one at fault.

Finally, I want to thank Virginia H. Knauer, Special Assistant to the President for Consumer Affairs, for her support and encouragement. She understood the importance of this book, and she gave me the time to work on it. Virginia is a solar enthusiast and has undertaken a number of significant efforts to give this important form of energy a viable start. When the history of solar power is written, she will be included in one of the first chapters.

Joe Dawson
Director of Public Affairs
Office of Consumer Affairs

# SOLAR SUBSYSTEMS—THE COLLECTOR

Every so often it seems, the American people learn about a totally new product in the marketplace. Several years ago, for instance, the hand electronic calculator was but a wink in a businessman's eye. Now, you can walk into almost any retail outlet and purchase one to keep your checking account in balance and to help figure out your income taxes.

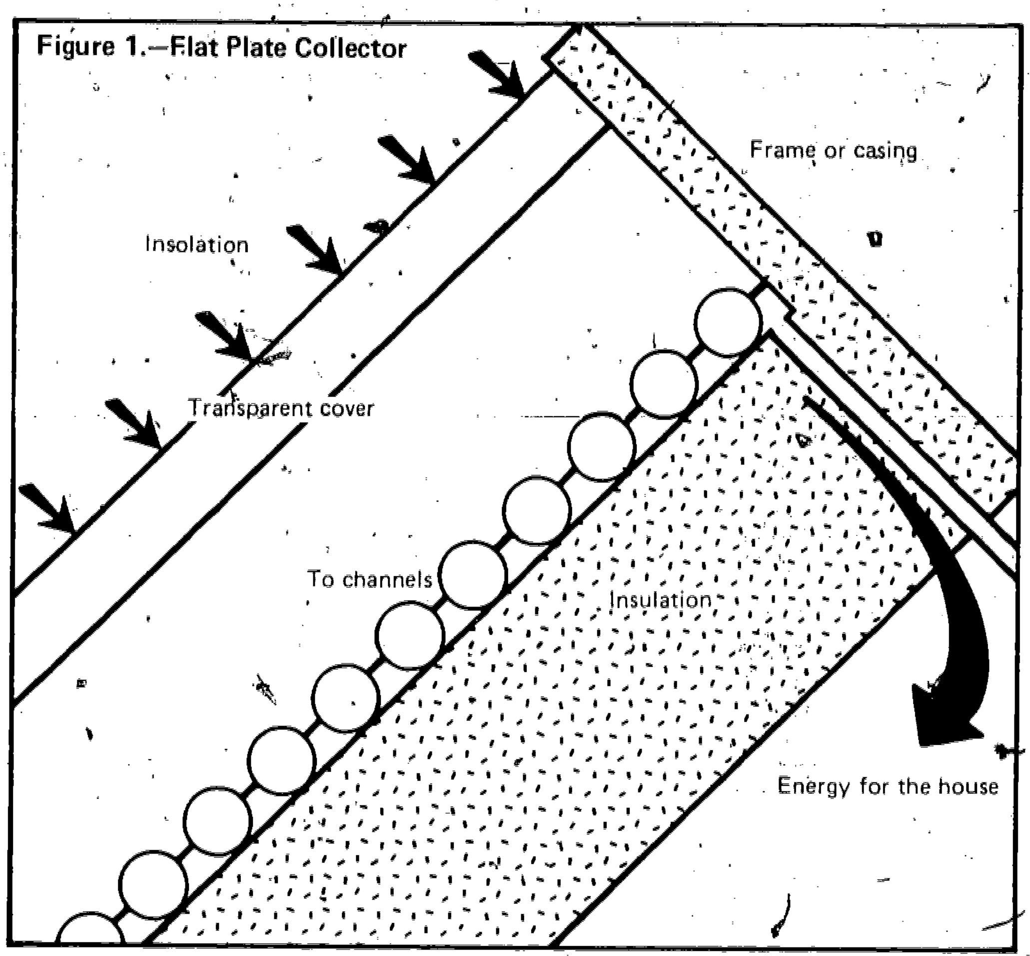
Similarly, it wasn't too long ago when stereo systems first came on the marketplace, and Americans heard a totally new language—woofers, tweeters, anti-static devices, distortion levels, etc. To choose properly, consumers had to learn what these terms meant, and then they had to learn how to compare competing products. Because so many Americans took the time and trouble to learn these essentials, stereo manufacturers by and large fought for the consumer's business by selling quality rather than imagery. Two important results occurred—superior products and satisfied customers.

Will solar evolve, as stereo did, into a widespread, beneficial industry? To a great extent, that answer depends upon you, the American consumer. The more people who take the time and effort to become good buyers, the greater the chance that solar power will reach its full potential—providing safe, economical energy to millions of American families.

To be a good buyer of solar systems does not mean you have to become a mechanical or an architectural engineer. It does mean that at the right time, you should call on one of these experts to give you specific advice for your specific home. But before you get to the point of bringing in the expert there is a lot you can do to decide whether solar is for your home, and what type of unit is best for your needs

Perhaps the best place to start is with knowledge of how solar works and the various main subsystems that make up a solar system which are the collector storage, the distribution network, and controls

**Figure 1.—Flat Plate Collector**



The solar collector is the subsystem most people think about when solar energy is discussed. This is the component whose main function is to capture the sun's energy. There are many types of collectors available: high performance collectors such as the focusing collector which tracks the sun, a vacuum-sealed collector which has very low heat loss, and the more conventional flat plate collector. To understand the principle upon which a collector operates, let's take a look at the flat plate collector which has been used successfully for residential and commercial purposes.

Beyond the casing and the insulation the flat plate collector (see Figure 1) has three main elements the transparent cover or covers the collector plate known to engineers as the absorber and the channels in the collector plate

The transparent cover can be made out of glass or plastic. It is hard to generalize about the advantages and disadvantages of each material because various products differ in quality.

Glass holds its transparent characteristics well over the years. However, various quality characteristics such as transparency, strength, etc., vary from product to product. The same can be said of plastics Some contain high transparency characteristics for long periods of time, while others do not. Some turn yellow, reducing the capability to transmit solar radiation. Some glass and plastic covers are almost vandal-proof, while others can be damaged very easily.

Some nonconductive material should separate the cover from the frame to decrease conduction losses

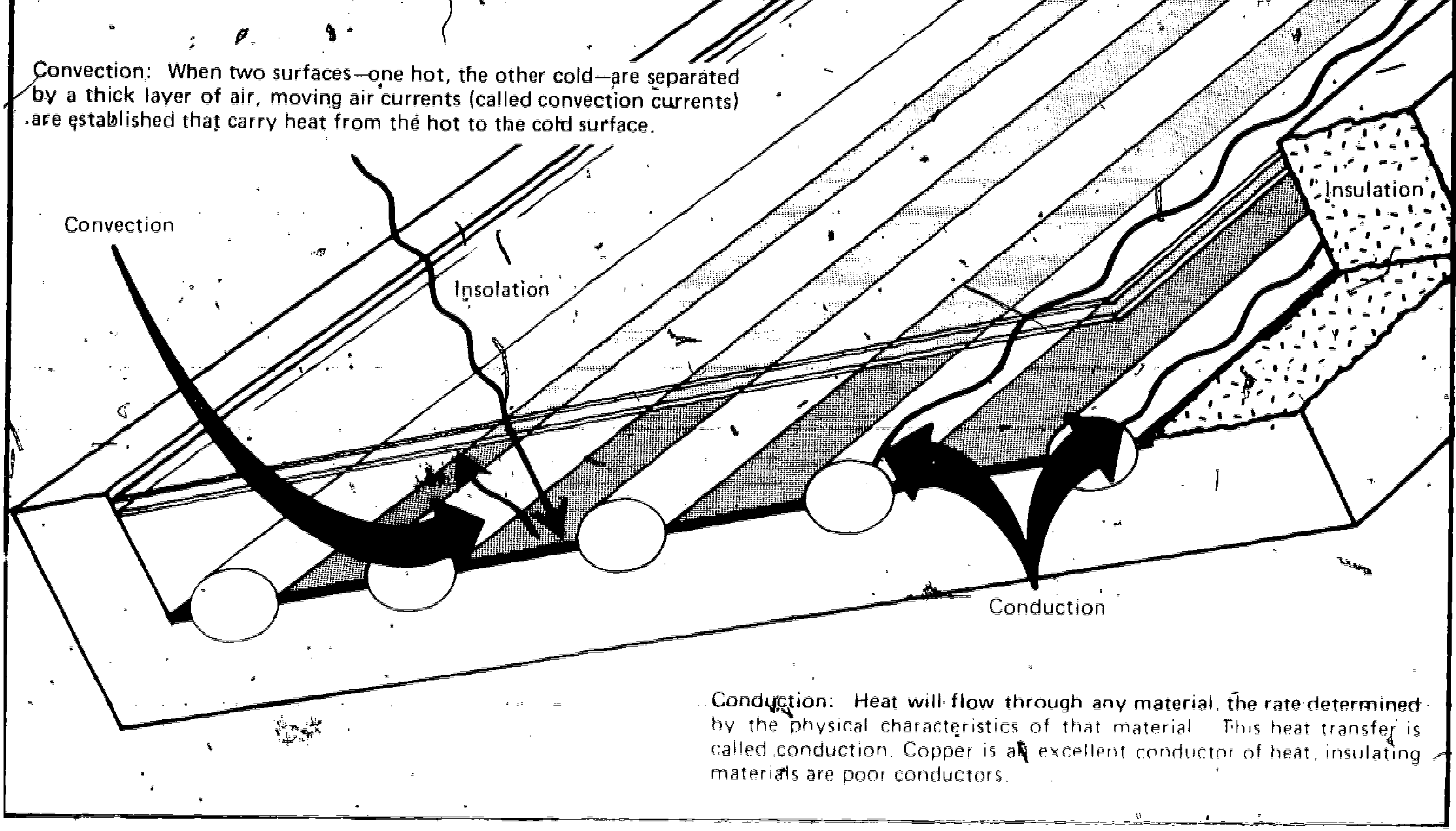
In selecting collectors of different materials, the consumer should ask for test reports that show anticipated durability and transparency characteristics. You can then give these reports to your engineering consultant for evaluation.

The transparent cover serves many purposes. It keeps outside air from carrying away the heat that has been trapped. It also keeps out the wind and the elements, protecting the inside components and reducing energy loss by convection. In warm areas, one cover is usually all that is necessary, but in colder climates, two transparent covers or insulated glass are generally considered necessary.

Here is how the typical flat plate collector works. Solar radiation passes through the transparent cover (a small portion is absorbed or reflected off the cover's surface) and hits the absorber plate. Most of the radiation is absorbed by the plate and picked up by the fluid (air, water, or other liquids) passing through the channels in or against the plate. Some of the radiation is reflected off the plate back to the cover—how much depends upon the absorbing and reflecting characteristics of the coating on the collector plate. The better the absorbing quality, the more radiation captured; the less reflected back to the cover. Special coatings have been developed which are highly absorptive with low reradiation. Don't be turned off by a collector plate because it is black or a dark color; dark colors absorb radiation much better than light colors. Conversely, you can't always tell by the color whether the coating has the desired selectivity characteristics.

Some manufacturers are developing what is known as selective surfaces for the collector plate. These are not painted, but rather specially coated metals that appear to be a technical improvement over flat black paint because reradiation losses are decreased. Selective surfaces cost more initially than flat black paint, and the extra cost must be weighed against the value of increased efficiency and the life expectancy of the coating. No matter what coating or metal is used, however, some portion of the incoming radiation will be radiated back, and of that portion, the transparent cover either will allow some to pass through or absorb the rest. The reason for two transparent covers in some collectors is to improve the insulation, just as storm windows on your house reduce the loss of heat through the window. More than two covers are not necessary. Still other por-

**Figure 2.—How a Flat Plate Collector Works**



Convection: When two surfaces—one hot, the other cold—are separated by a thick layer of air, moving air currents (called convection currents) are established that carry heat from the hot to the cold surface.

Conduction: Heat will flow through any material, the rate determined by the physical characteristics of that material. This heat transfer is called conduction. Copper is an excellent conductor of heat, insulating materials are poor conductors.

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tion by the metal in the plate and through the insulation on the back and [illegible] Figure 2). How much is lost through conduction depends upon overall design of the collector. The net result of all these losses is that only a certain portion is absorbed by the passing fluid. The [illegible] the losses, the more efficient the collector.

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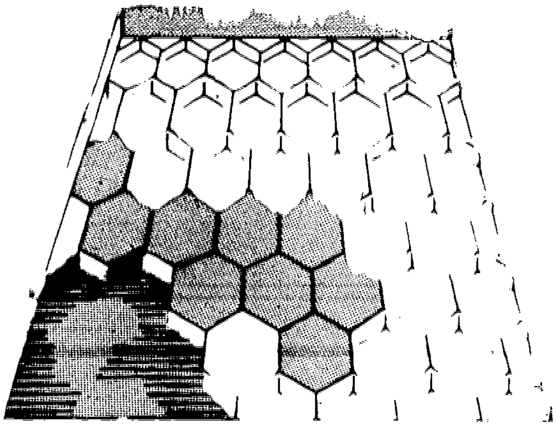

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[illegible] considerations. Metal corrosion can cause irreparable damage to a solar system and shorten a system's life span. More importantly, corrosion can cause serious health problems if the water is used directly by the [illegible]

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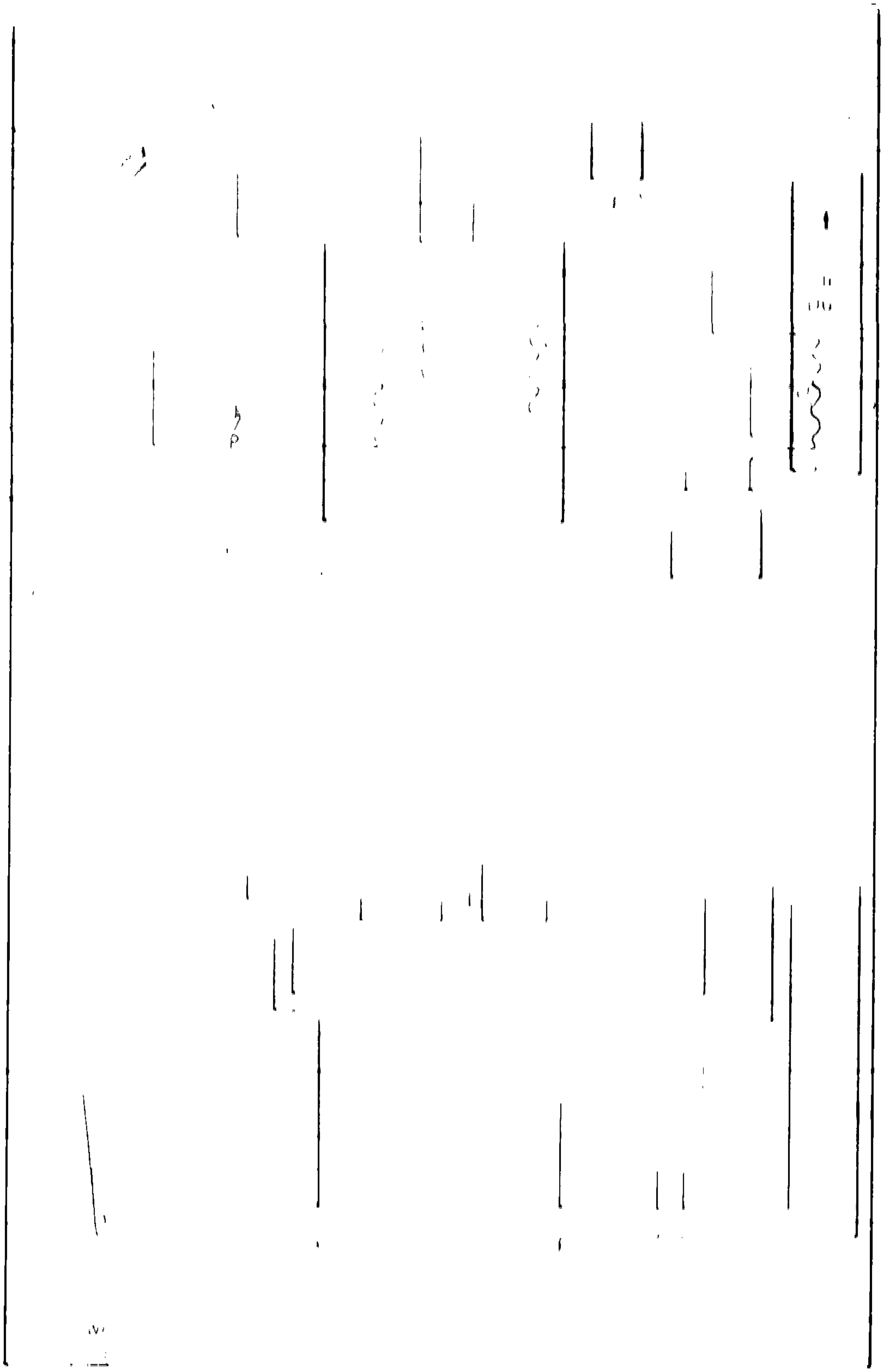
[illegible] will [illegible] If you [illegible] backing [illegible] sells, then your chances [illegible] factory service [illegible]

[illegible] most important points [illegible] (including [illegible] formance during the months [illegible] system the most [illegible] tem is expected to last before [illegible] replacement.



# THE STORAGE SUBSYSTEM

[illegible] system [illegible] heat [illegible] storage [illegible]

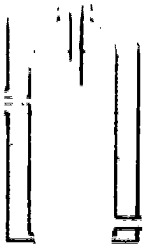
[illegible] age [illegible] storage [illegible] vantage [illegible]

Water [illegible] high heat capacity [illegible] heat effectively within a limited [illegible] of space. Water storage tanks [illegible] protected from freezing [illegible] side. Tanks [illegible] them [illegible] Storage [illegible]

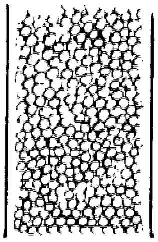
[illegible] take [illegible] tem [illegible]

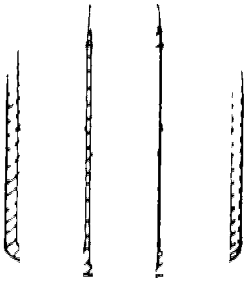
[illegible] tank [illegible] built [illegible] ment [illegible] tank [illegible]

[illegible] storage [illegible] ment [illegible] port [illegible] an area where [illegible] ing expert to [illegible] your home



[illegible] heat [illegible] but the tank [illegible] practical [illegible]





[illegible] Although the amount [illegible] needed in the collector [illegible] its cost is not an [illegible] generally not practical to fill the large storage tank with the antifreezing fluid; therefore, a heat exchanger must be used to transfer heat from the fluid in the collector system to the water in storage. If the collector fluid [illegible] heating system eliminates the heat exchanger and its cost, [illegible] cooling [illegible] draining [illegible] ter as [illegible]

[illegible] used that has a [illegible] ability of the [illegible] to reach higher temperatures is important because such heat will not go wasted if the collector delivers it.

For best results the [illegible] pebbles should be roughly spherical or uniform size and up to 2 inches in diameter. These provide minimum resistance to the air passing through. Other solids can be used also, but are usually much more expensive.

[illegible] change [illegible] that [illegible] from solid to [illegible] heated. The change [illegible] more heat per pound [illegible] material such as Glauber's salt [illegible] goes from a liquid to a solid [illegible] off [illegible] heat [illegible] still in the experimental stage.

[illegible] amount of [illegible] limited [illegible] 000 Btu [illegible] would [illegible] 5,500 pounds [illegible] 175 cubic feet [illegible] 500 pounds [illegible] Glauber's salts would require only 19 cubic feet [illegible] In addition, such salts are obtainable at relatively reasonable prices.

[illegible] major limitations of [illegible] salts [illegible] through so many cycles before their natural state is altered to the point where they lose their capacity to successfully store heat. There are some chemical additions which act to prolong the number of cycles considerably, and there are some interesting experiments which, if successful, may dynamically prolong the life span.

[illegible] than [illegible] product [illegible] could bring these costs down dramatically, but there are at present no marketable systems.

These are the two commercially [illegible] methods and one experimental method of storing heat. In choosing a system you should, as with a collector, determine whether and what type of warranties are available. Depending upon the system you will need to know answers to such specific questions as:

- [illegible]
- [illegible]
- [illegible] (As [illegible] upon [illegible]
- [illegible]
- [illegible]

# THE SOLAR SYSTEM

[illegible] collector [illegible] paratory [illegible] a solar energy system works and then determining whether you should invest in one and if so what type

There are [illegible] dential solar energy systems [illegible] water [illegible] domestic use heating swimming pool heating the home (space heating) and heating and cooling the home (space heating and cooling). Of course there are various combinations of these end uses. A [illegible] could be used to heat the house during the winter and the swimming [illegible] or early fall when [illegible] heating is not needed [illegible] handle [illegible] heating [illegible] and supplying [illegible]

[illegible] A[illegible] operat[illegible] forces [illegible] same [illegible] have [illegible]

[illegible] operate [illegible] regions heating [illegible] economically competitive with conventional forms of energy [illegible] systems are limited [illegible] tions and [illegible] work [illegible] temperatures [illegible] are [illegible] subject to [illegible] excessive humidity [illegible] able to provide [illegible] levels. In most cases the require[illegible] of a passive system will dictate [illegible] design of the structure more so than with active systems. For instance one type of passive cooling system requi[illegible] a water pond on the roof w[illegible] shutters wh[illegible] the [illegible] evaporation and nocturnal radiation [illegible] the shutters are closed during the daytime to prevent reheating. This system is most effective in areas of low humidity with [illegible] night skies

[illegible] than [illegible] system but [illegible] economical in terms of Btu's delivered per dollar invested. Active systems are not as architecturally restrictive as passive systems.

[illegible] manufacturers [illegible] passive and active techniques [illegible] some of the economic values of the passive equipment with some of the versatility of the active method. These are called hybrid systems.

[illegible] active [illegible] solar [illegible] For [illegible] solar [illegible] designed to [illegible] hand [illegible] designed [illegible] load [illegible] cost

[illegible] this [illegible] be prepared [illegible] array of components [illegible] changers [illegible] valves [illegible] trols piping supports and [illegible]

[illegible] known [illegible] water heating. Th[illegible] in use [illegible] Florida since [illegible] and they have an overall record of acceptable performance when properly constructed and maintained.

[illegible] and size of the unit [illegible] offered, installation costs and other variables. Because of fuel savings they can return the original costs or pay for themselves within a reasonable period of time if replacing electricity or high priced fuel. The payback period depends upon the cost of [illegible] heating [illegible] by [illegible] installation rate and [illegible] efficiency of the unit. Generally [illegible] to save 5[illegible] percent of y[illegible]

[illegible] ate. [illegible] water [illegible] established [illegible] safe drinking water.

[illegible] with a [illegible] feel [illegible] 80 [illegible]

[illegible] as a hot water system except that the storage area is not the hot water tank but the swimming pool. A number of experts sug [illegible] designed [illegible] heat domestic hot water. If you should decide to have a dual purpose system make sure that [illegible] collector is selected carefully.

Some [illegible] heat [illegible] unglazed collectors. They can [illegible] since the temperature to which it is desired to heat the pool is only a [illegible] few degrees above the outside air temperature. Unglazed collectors [illegible] inefficient when operated at high temperatures and may not be suitable for dual purposes.

[illegible] way to [illegible] the pool [illegible] simply [illegible] durable [illegible] the water surface [illegible] pool [illegible] peratures [illegible] for several [illegible] ments.

[illegible] pool [illegible] safety [illegible]

[illegible] though [illegible] may [illegible] could go [illegible] radiation. [illegible] tion can also be used [illegible] summer months if the [illegible] uncomfortably warm.

[illegible] solar unit to [illegible] the compatibility [illegible] tional heating systems [illegible] supposed to work together are the important considerations you should obtain professional guidance on these matters.

Costs for swimming pool solar systems vary according to the temperature you

[illegible] the [illegible]

[illegible] system [illegible] to the [illegible] matically reducing monthly [illegible] Earlier we discussed advantages and disadvantages of various components within a system. These of course carry over to the system itself. Let's add up some of the pros and the cons of [illegible] systems.

[illegible] of [illegible] heat [illegible] pacity [illegible] or cool liquid and [illegible] temperature to a useful [illegible] used [illegible] the [illegible] from the [illegible] side

[illegible] refrigerant [illegible]

[illegible] to expand to a low pressure [illegible] pressure [illegible] pick up more [illegible] to begin the cycle all over again

[illegible] in storage [illegible] the [illegible] needs to [illegible] useful [illegible]

[illegible] tracted from [illegible]

[illegible] the [illegible] Outdoor air is [illegible] have the [illegible] design [illegible] heat pump [illegible] mild [illegible] but solar [illegible] supplement [illegible]

[illegible] to use [illegible] adopts [illegible] lower [illegible] solar [illegible] 25 [illegible] percent [illegible] be [illegible]

[illegible] question [illegible]

[illegible]

storage [illegible]

enough [illegible]

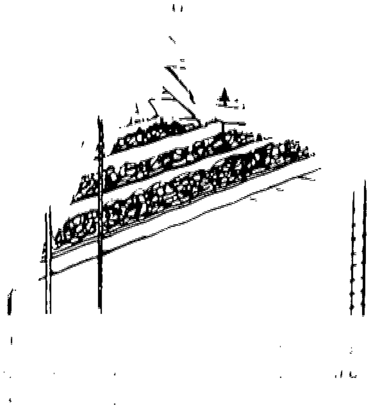
6) [illegible]

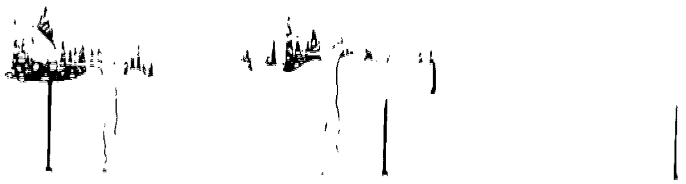
later [illegible]

you [illegible]

[illegible] square feet [illegible] square feet [illegible] square feet [illegible] cover [illegible] pool

There [illegible]





Sim [illegible] of [illegible] for heating [illegible] percent [illegible] than 80 percent

In [illegible] heating [illegible] home [illegible] insula[illegible] point [illegible] wall [illegible] solar system

Be sur[illegible] loss [illegible] the

[illegible]

*It* [illegible] *the* [illegible] *an*[illegible] *ther* [illegible]

Th[illegible] sola[illegible] you [illegible] insulate [illegible] determin[illegible] sola[illegible] system [illegible] ment. You will [illegible] coun[illegible] and [illegible] energy systems [illegible]

A [illegible] ways [illegible] and [illegible] insulation [illegible] facturing solar [illegible] pressed through [illegible] value. The U value stands for the [illegible]

[illegible] 24 [illegible] first [illegible] flow of wind. [illegible] considerably This [illegible] larger [illegible] se

[illegible]

then [illegible] you [illegible] better determine [illegible] a sound investment for you. Methods of determining the feasibility of installing solar in individual homes can be found in the Appendix [illegible]

In [illegible] ple[illegible] In an [illegible] energy system and in [illegible] tant to bring in the arc[illegible] possible, before the site [illegible] lected. Be sure that the architect has [illegible] experience in designing solar energy systems. Solar designing [illegible] requiring knowledge [illegible] ical and architectural [illegible] gether.

A [illegible] g the[illegible] part[illegible] ture [illegible] able [illegible] solar [illegible] of [illegible] rights (see below) [illegible] the building code [illegible] other applicable [illegible] proper design [illegible] use of energy [illegible] such [illegible] down [illegible]

It is [illegible] consult [illegible] before [illegible] where [illegible] could possibly be [illegible] future dispute over solar rights.

Very [illegible] legal issue concerning [illegible] sun's rays [illegible] you [illegible] which blocks the rays [illegible] reaching the collector [illegible] thing about the tree? Or [illegible] tree supposing it is a [illegible] What legal rights do you have?

[illegible] plain common sense. If you are in an area that is [illegible] and you have enough space for [illegible] that [illegible] But if [illegible] little [illegible] law providing [illegible] May [illegible]

[illegible] make good [illegible]

[illegible] and [illegible] collector [illegible] be in- [illegible] ch. [illegible] ally [illegible] that [illegible]

# SOLAR AS AN INVESTMENT

[illegible]

hou [illegible] the [illegible] on degree [illegible]

Once [illegible] approximate [illegible] will [illegible] how many [illegible] delivered [illegible] determine [illegible] insulation [illegible] mod in your [illegible] the [illegible] of your [illegible] system and the portion of the collected solar heat that [illegible] be [illegible]

[illegible] the [illegible] fuel [illegible] the [illegible] is [illegible] be [illegible] at [illegible] be [illegible] one [illegible] ing [illegible]

The [illegible] mal [illegible] hand [illegible] ably [illegible]

Fu[illegible] are [illegible] flect inefficie[illegible] systems [illegible] of [illegible] 55 [illegible] burne[illegible] not tak[illegible] these [illegible]

Another [illegible] well insulate[illegible] heat losses

[illegible] because [illegible] particularly attractive [illegible] home [illegible] the [illegible]

[illegible] do [illegible] the basic [illegible]

[illegible] solar [illegible]

- [illegible]
- [illegible]
- Unusual weather [illegible]

[illegible] temperature [illegible] of 65 degrees [illegible] day [illegible] degree [illegible] on page [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible] ption
- [illegible]
- [illegible] used
- [illegible]

- [illegible]
- [illegible]
- [illegible]

- Length of swimming season without heat.
- Desired length of use.
- Temperature and source of water supply.
- The presence or lack of a wind barrier.

For space heating and cooling, the following information is needed:

- The orientation of the house.
- Floor area of the home, and the number of stories.
- Type of construction used, type and extent of insulation.
- The mean U value or heat loss of the home, including infiltration and ventilation.
- Previous bills and rates.
- Desired temperature levels.

Beyond the weather and specific use data, topographical information, latitude, altitude, and description of the specific site—hills, trees, valleys, etc.—will also be needed.

If you buy a solar system without taking all these factors into account, then, frankly, you are gambling.

Actually determining the amount of Btu's delivered is a rather complicated process, and readers may want to skip the following explanation. But you may want to look at how one manufacturer calculates Btu usage.

**{This Solar System Will Handle Up To 90 Percent of Your Heating Needs}**

Beware of simplistic claims. They generally have a catch. The above claim may only apply to homes that have extravagant insulation. Below is a more modest and more accurate claim.

**On a Good Sunny Day, This Solar System Will Handle Between 40 and 60 Percent of Your Heating Needs.**

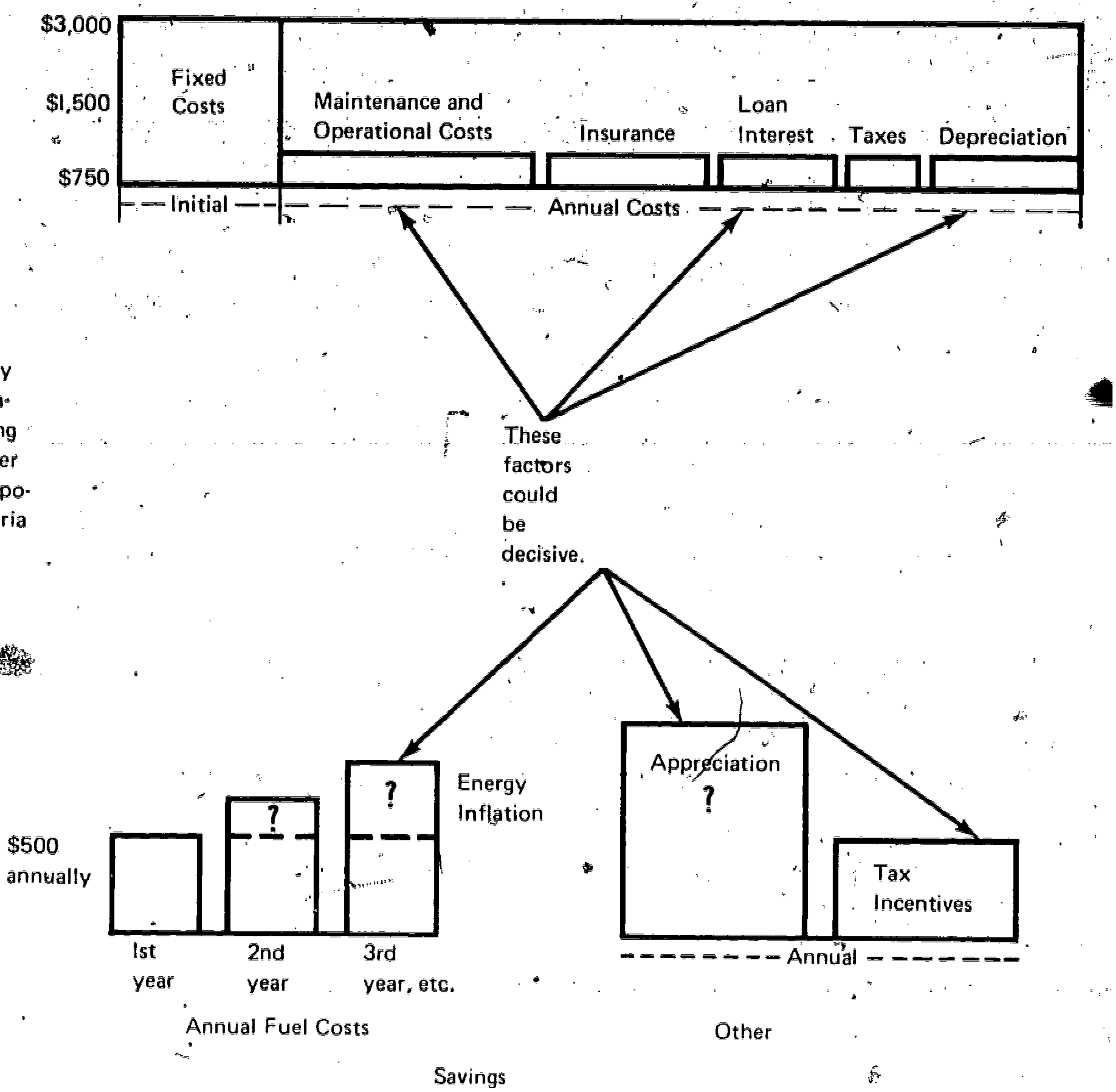
Knowing the differences among warranties can make a big difference in your pocketbook.

**FULL WARRANTY**

This product is guaranteed against all defects in construction and against corrosion for a period of 5 years. Manufacturer will pay for all labor and parts costs to correct problems.

**LIMITED WARRANTY**

This product is guaranteed to be one of the finest solar systems ever manufactured. Manufacturer will pay for costs of parts to correct any problem.



Life cycle costing is a method whereby the total costs of a product can be measured against the annual savings, showing the buyer approximately when his or her investment is paid for. The above is a hypothetical example showing some key criteria in such an evaluation.

The following procedure is used to determine precise fuel savings for specific collector areas:

Nomenclature

Design Load - The design heating load of the residence or commercial building of interest.

Design Temperature - The winter outdoor design temperature for the building location (i.e. in Denver the Design Temperature = 0° F)

Internal Heat Gain - The internal heat gain of the building due to lights, occupancy and machinery. For residences this is generally assumed to be 0.

$A_c$ - The collector area in square feet

UA - The heat loss per degree day of the building. This number is obtained from the Design Load. Multiply the Design Load by 24 hours and divide the product by the design T(70 - Design Temperature).

qu - The useful heat gain from the collector on a per square foot basis. The dimensions of this number are BTU/ft² - month.

dg dys/month - The 30 year average degree days per month where dg days = $\left(65 - \frac{T_{maximum} + T_{minimum}}{2}\right)$ $T_{maximum}$ = daily maximum temperature

$T_{minimum}$ = daily minimum temperature.

These numbers are tabulated by the National Weather Service.

Heat Load - The total average heat load per month which equals UA × dg dys.

Procedure

The Design Load is taken directly from the Heat Loss Calculation. The Design Temperature is taken from ASHRAE or Manual J. The Internal Heat Gain is obtained from the Heat Loss and Gain Summary for a commercial building. The Internal Heat Gain in such a summary is usually given in BTU/hr, and must be converted into BTU/Month. To do this, the Internal Heat Gain in BTU/hr is multiplied by the number of hours per month the heat addition to the building is occuring. For example, if the internal heat gain from lights and people is given as 10,000 BTU/hr for an office building, then the total for one month is:

$$\text{Int. Ht. Gn} = 10{,}000\ \frac{\text{BTU}}{\text{hr}} \times \frac{8\ \text{hours}}{\text{day}} \times \frac{21\ \text{working days}}{\text{month}} = 1{,}680{,}000\ \text{BTU/month}$$

The UA of a building is the heat loss per dg dy of the building and is obtained directly from the design heat load as explained under Nomenclature above. This calculation assumes the building is to be kept at approximately 70° F, and if this is not the case, the performance chart cannot be used directly.

qu and dg dys/month have been tabulated for several locations in Table II

The tabulated values of qu and the collector output in BTU/Sq Ft per month are entered in Column 1 of the percent annual fuel savings worksheet (Worksheet II)

Column 2 is the total heat gain from the collector and is obtained by multiplying qu by $A_c$, the collector area.

Dg dys/month are entered in Column 3.

Column 5 is the portion of the total heat loss which has to be met by the heating system. These numbers are obtained by subtracting the internal heat gain from the total heat loss calculated in Column 4. If the difference is negative, enter 0.

Column 6 is the portion of the heat load met by the back up system. It is obtained by subtracting the numbers in Column 2 (the total heat gain from the collector) from the corresponding numbers in Column 5 (the Heat load). If this number is negative, then the solar system has satisfied the entire load and 0 is entered.

Column 7 is the percentage of the load carried by solar for each month and is obtained by subtracting Column 6 from Column 5, dividing the product by Column 6 and multiplying by 100 percent. The annual percentage of the load carried by solar is obtained similarly to the monthly percentages. The total from Column 5, dividing the product by the total of Column 6, and multiplying by 100 percent.

## Worksheet II - Sample Problems

Sample Worksheets A through E provide details for Worksheet II use based on a house in Boston, Massachusetts with a design heat load of 68,790 BTU/hour. The design ambient temperature is 10°F. These worksheets show performance for collector areas of 500 square feet, 1,000 square feet, 1,200 square feet and 1,500 square feet. It can be clearly seen that as collector area increases, the number of months in which the Solaron system provides 100 percent of the monthly heating requirement increases from three months at 500 square feet to five months at 1,200 square feet. It also becomes apparent when totaling the percent of solar heating from 500 square feet of collector at 39.8 percent and from 1,000 square feet of collector at 67.1 percent, that more than doubling the collector area does not necessarily double the percent of total heating provided by the solar system. This is, of course, a function of climatological data. From such a presentation, the proper collector area from a cost effectiveness viewpoint can be selected. The worksheets provide the following summary for the sample structure:

| Collector Area Square Feet | % of Total Heating Provided by Solar |
|---|---|
| 500 | 39.8 |
| 800 | 56.8 |
| 1,000 | 67.1 |
| 1,200 | 76.1 |
| 1,500 | 85.8 |

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Source Colorado State University

## Normal Total Heating Degree Days (Base 65°)

| STATE AND STATION | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALA. BIRMINGHAM | 0 | 0 | 6 | 93 | 363 | 555 | 592 | 462 | 363 | 108 | 9 | 0 | 2551 |
| HUNTSVILLE | 0 | 0 | 12 | 127 | 426 | 663 | 694 | 557 | 434 | 138 | 19 | 0 | 3070 |
| MOBILE | 0 | 0 | 0 | 22 | 213 | 357 | 415 | 300 | 211 | 42 | 0 | 0 | 1560 |
| MONTGOMERY | 0 | 0 | 0 | 68 | 330 | 527 | 543 | 417 | 316 | 90 | 0 | 0 | 2291 |
| ALASKA ANCHORAGE | 245 | 291 | 516 | 930 | 1284 | 1572 | 1631 | 1316 | 1293 | 879 | 592 | 315 | 10864 |
| ANNETTE | 242 | 208 | 327 | 567 | 738 | 899 | 949 | 837 | 843 | 648 | 490 | 321 | 7069 |
| BARROW | 803 | 840 | 1035 | 1500 | 1971 | 2362 | 2517 | 2332 | 2468 | 1944 | 1445 | 957 | 20174 |
| BARTER IS. | 735 | 775 | 987 | 1482 | 1944 | 2337 | 2536 | 2369 | 2477 | 1923 | 1373 | 924 | 19862 |
| BETHEL | 319 | 394 | 612 | 1042 | 1434 | 1866 | 1903 | 1590 | 1655 | 1173 | 806 | 402 | 13196 |
| COLD BAY | 474 | 425 | 525 | 772 | 918 | 1122 | 1153 | 1036 | 1122 | 951 | 791 | 591 | 9880 |
| CORDOVA | 366 | 391 | 522 | 781 | 1017 | 1221 | 1299 | 1086 | 1113 | 864 | 660 | 444 | 9764 |
| FAIRBANKS | 171 | 332 | 642 | 1203 | 1833 | 2254 | 2359 | 1901 | 1739 | 1068 | 555 | 222 | 14279 |
| JUNEAU | 301 | 338 | 483 | 725 | 921 | 1135 | 1237 | 1070 | 1073 | 810 | 601 | 381 | 9075 |
| KING SALMON | 313 | 322 | 513 | 908 | 1290 | 1606 | 1600 | 1333 | 1411 | 966 | 673 | 408 | 11343 |
| KOTZEBUE | 381 | 446 | 723 | 1249 | 1728 | 2127 | 2192 | 1932 | 2080 | 1554 | 1057 | 636 | 16105 |
| MCGRATH | 208 | 338 | 633 | 1184 | 1791 | 2232 | 2294 | 1817 | 1758 | 1122 | 648 | 258 | 14283 |
| NOME | 481 | 496 | 693 | 1094 | 1455 | 1820 | 1879 | 1666 | 1770 | 1314 | 930 | 573 | 14171 |
| SAINT PAUL | 605 | 539 | 612 | 862 | 963 | 1197 | 1228 | 1168 | 1265 | 1098 | 936 | 726 | 11199 |
| SHEMYA | 577 | 475 | 501 | 784 | 876 | 1042 | 1045 | 958 | 1011 | 885 | 837 | 696 | 9687 |
| YAKUTAT | 338 | 347 | 474 | 716 | 936 | 1144 | 1169 | 1019 | 1042 | 840 | 632 | 435 | 9092 |
| ARIZ. FLAGSTAFF | 46 | 68 | 201 | 558 | 867 | 1073 | 1169 | 991 | 911 | 651 | 437 | 180 | 7152 |
| PHOENIX | 0 | 0 | 0 | 22 | 234 | 415 | 474 | 328 | 217 | 75 | 0 | 0 | 1765 |
| PRESCOTT | 0 | 0 | 27 | 245 | 579 | 797 | 865 | 711 | 605 | 360 | 158 | 15 | 4362 |
| TUCSON | 0 | 0 | 0 | 25 | 231 | 406 | 471 | 344 | 242 | 75 | 6 | 0 | 1800 |
| WINSLOW | 0 | 0 | 6 | 245 | 711 | 1008 | 1054 | 770 | 601 | 291 | 96 | 0 | 4782 |
| YUMA | 0 | 0 | 0 | 0 | 148 | 319 | 363 | 228 | 130 | 29 | 0 | 0 | 1217 |
| ARK. FORT SMITH | 0 | 0 | 12 | 127 | 450 | 704 | 781 | 596 | 456 | 144 | 22 | 0 | 3292 |
| LITTLE ROCK | 0 | 0 | 9 | 127 | 465 | 716 | 756 | 577 | 434 | 126 | 9 | 0 | 3219 |
| TEXARKANA | 0 | 0 | 0 | 78 | 345 | 561 | 626 | 468 | 350 | 105 | 0 | 0 | 2533 |
| CALIF. BAKERSFIELD | 0 | 0 | 0 | 37 | 282 | 502 | 546 | 364 | 267 | 105 | 19 | 0 | 2122 |
| BISHOP | 0 | 0 | 42 | 248 | 576 | 797 | 874 | 666 | 539 | 306 | 143 | 36 | 4227 |
| BLUE CANYON | 34 | 50 | 120 | 347 | 579 | 766 | 865 | 781 | 791 | 582 | 397 | 195 | 5507 |
| BURBANK | 0 | 0 | 6 | 43 | 177 | 301 | 366 | 277 | 239 | 138 | 81 | 18 | 1646 |
| EUREKA | 270 | 257 | 258 | 329 | 414 | 499 | 546 | 470 | 505 | 438 | 372 | 285 | 4643 |
| FRESNO | 0 | 0 | 0 | 78 | 339 | 558 | 586 | 406 | 319 | 150 | 56 | 0 | 2492 |
| LONG BEACH | 0 | 0 | 12 | 40 | 156 | 288 | 375 | 297 | 267 | 168 | 90 | 18 | 1711 |
| LOS ANGELES | 28 | 22 | 42 | 78 | 180 | 291 | 372 | 302 | 288 | 219 | 158 | 81 | 2061 |
| MT. SHASTA | 25 | 34 | 123 | 406 | 696 | 902 | 983 | 784 | 738 | 525 | 347 | 159 | 5722 |
| OAKLAND | 53 | 50 | 45 | 127 | 309 | 481 | 527 | 400 | 353 | 255 | 180 | 90 | 2870 |
| POINT ARGUELLO | 202 | 186 | 162 | 205 | 291 | 400 | 474 | 392 | 403 | 339 | 298 | 243 | 3595 |
| RED BLUFF | 0 | 0 | 0 | 53 | 318 | 555 | 605 | 428 | 341 | 168 | 47 | 0 | 2515 |
| SACRAMENTO | 0 | 0 | 12 | 81 | 363 | 577 | 614 | 442 | 360 | 216 | 102 | 6 | 2773 |
| SANDBERG | 0 | 0 | 30 | 202 | 480 | 691 | 778 | 661 | 620 | 426 | 264 | 57 | 4209 |
| SAN DIEGO | 6 | 0 | 15 | 37 | 123 | 251 | 313 | 249 | 202 | 123 | 84 | 36 | 1439 |
| SAN FRANCISCO | 81 | 78 | 60 | 143 | 306 | 462 | 508 | 395 | 363 | 279 | 214 | 126 | 3015 |
| SANTA CATALINA | 16 | 0 | 9 | 50 | 165 | 279 | 353 | 308 | 326 | 249 | 192 | 105 | 2052 |
| SANTA MARIA | 99 | 93 | 96 | 146 | 270 | 391 | 459 | 370 | 363 | 282 | 233 | 165 | 2967 |
| COLO. ALAMOSA | 65 | 99 | 279 | 639 | 1065 | 1420 | 1476 | 1162 | 1020 | 696 | 440 | 168 | 8529 |
| COLORADO SPRINGS | 9 | 25 | 132 | 456 | 825 | 1032 | 1128 | 938 | 893 | 582 | 319 | 84 | 6423 |
| DENVER | 6 | 9 | 117 | 428 | 819 | 1035 | 1132 | 938 | 887 | 558 | 288 | 66 | 6283 |
| GRAND JUNCTION | 0 | 0 | 30 | 313 | 786 | 1113 | 1209 | 907 | 729 | 387 | 146 | 21 | 5641 |
| PUEBLO | 0 | 0 | 54 | 326 | 750 | 986 | 1085 | 871 | 772 | 429 | 174 | 15 | 5462 |
| CONN. BRIDGEPORT | 0 | 0 | 66 | 307 | 615 | 986 | 1079 | 966 | 853 | 510 | 208 | 27 | 5617 |
| HARDFORT | 0 | 6 | 99 | 372 | 711 | 1119 | 1209 | 1061 | 899 | 495 | 177 | 24 | 6172 |
| NEW HAVEN | 0 | 12 | 87 | 347 | 648 | 1011 | 1097 | 991 | 871 | 543 | 245 | 45 | 5897 |
| DEL. WILMINGTON | 0 | 0 | 51 | 270 | 588 | 927 | 980 | 874 | 735 | 387 | 112 | 6 | 4930 |
| FLA. APALACHICOLA | 0 | 0 | 0 | 16 | 153 | 319 | 347 | 260 | 180 | 33 | 0 | 0 | 1308 |
| DAYTONA BEACH | 0 | 0 | 0 | 0 | 75 | 211 | 248 | 190 | 140 | 15 | 0 | 0 | 879 |
| FORT MYERS | 0 | 0 | 0 | 0 | 24 | 109 | 146 | 101 | 62 | 0 | 0 | 0 | 442 |
| JACKSONVILLE | 0 | 0 | 0 | 12 | 144 | 310 | 332 | 246 | 174 | 21 | 0 | 0 | 1239 |
| KEY WEST | 0 | 0 | 0 | 0 | 0 | 28 | 40 | 31 | 9 | 0 | 0 | 0 | 108 |
| LAKELAND | 0 | 0 | 0 | 0 | 57 | 164 | 195 | 146 | 99 | 0 | 0 | 0 | 661 |
| MIAMI BEACH | 0 | 0 | 0 | 0 | 0 | 40 | 56 | 36 | 9 | 0 | 0 | 0 | 141 |
| ORLANDO | 0 | 0 | 0 | 0 | 72 | 198 | 220 | 165 | 105 | 6 | 0 | 0 | 766 |
| PENSACOLA | 0 | 0 | 0 | 19 | 195 | 353 | 400 | 277 | 183 | 36 | 0 | 0 | 1463 |
| TALLAHASSEE | 0 | 0 | 0 | 28 | 198 | 360 | 375 | 286 | 202 | 36 | 0 | 0 | 1485 |
| TAMPA | 0 | 0 | 0 | 0 | 60 | 171 | 202 | 148 | 102 | 0 | 0 | 0 | 683 |
| WEST PALM BEACH | 0 | 0 | 0 | 0 | 6 | 65 | 87 | 64 | 31 | 0 | 0 | 0 | 253 |

Normal Total Heating Degree Days (Base 65°)

| STATE AND STATION | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA. ATHENS | 0 | 0 | 12 | 115 | 405 | 632 | 642 | 529 | 431 | 141 | 22 | 0 | 2929 |
| ATLANTA | 0 | 0 | 18 | 127 | 414 | 626 | 639 | 529 | 437 | 168 | 25 | 0 | 2983 |
| AUGUSTA | 0 | 0 | 0 | 78 | 333 | 552 | 549 | 445 | 350 | 90 | 0 | 0 | 2397 |
| COLUMBUS | 0 | 0 | 0 | 87 | 333 | 543 | 552 | 434 | 338 | 96 | 0 | 0 | 2383 |
| MACON | 0 | 0 | 0 | 71 | 297 | 502 | 505 | 403 | 295 | 63 | 0 | 0 | 2136 |
| ROME | 0 | 0 | 24 | 161 | 474 | 701 | 710 | 577 | 468 | 177 | 34 | 0 | 3326 |
| SAVANNAH | 0 | 0 | 0 | 47 | 246 | 437 | 437 | 353 | 254 | 45 | 0 | 0 | 1819 |
| THOMASVILLE | 0 | 0 | 0 | 25 | 198 | 366 | 394 | 305 | 208 | 33 | 0 | 0 | 1529 |
| IDAHO BOISE | 0 | 0 | 132 | 415 | 792 | 1017 | 1113 | 854 | 722 | 438 | 245 | 81 | 5809 |
| IDAHO FALLS 46W | 16 | 34 | 270 | 623 | 1056 | 1370 | 1538 | 1249 | 1085 | 651 | 391 | 192 | 8475 |
| IDAHO FALLS 42NW | 16 | 40 | 282 | 648 | 1107 | 1432 | 1600 | 1291 | 1107 | 657 | 388 | 192 | 8760 |
| LEWISTON | 0 | 0 | 123 | 403 | 756 | 933 | 1063 | 815 | 694 | 426 | 239 | 90 | 5542 |
| POCATELLO | 0 | 0 | 172 | 493 | 900 | 1166 | 1324 | 1058 | 905 | 555 | 319 | 141 | 7033 |
| ILL. CAIRO | 0 | 0 | 36 | 164 | 513 | 791 | 856 | 680 | 539 | 195 | 47 | 0 | 3821 |
| CHICAGO | 0 | 0 | 81 | 326 | 753 | 1113 | 1209 | 1044 | 890 | 480 | 211 | 48 | 6155 |
| MOLINE | 0 | 9 | 99 | 335 | 774 | 1181 | 1314 | 1100 | 918 | 450 | 189 | 39 | 6408 |
| PEORIA | 0 | 6 | 87 | 326 | 759 | 1113 | 1218 | 1025 | 849 | 426 | 183 | 33 | 6025 |
| ROCKFORD | 6 | 9 | 114 | 400 | 837 | 1221 | 1333 | 1137 | 961 | 516 | 236 | 60 | 6830 |
| SPRINGFIELD | 0 | 0 | 72 | 291 | 696 | 1023 | 1135 | 935 | 769 | 354 | 136 | 18 | 5429 |
| IND. EVANSVILLE | 0 | 0 | 66 | 220 | 606 | 896 | 955 | 767 | 620 | 237 | 68 | 0 | 4435 |
| FORT WAYNE | 0 | 9 | 105 | 378 | 783 | 1135 | 1178 | 1028 | 890 | 471 | 189 | 39 | 6205 |
| INDIANAPOLIS | 0 | 0 | 90 | 316 | 723 | 1051 | 1113 | 949 | 809 | 432 | 177 | 39 | 5699 |
| SOUTH BEND | 0 | 6 | 111 | 372 | 777 | 1125 | 1221 | 1070 | 933 | 525 | 239 | 60 | 6439 |
| IOWA Burlington | 0 | 0 | 93 | 322 | 768 | 1135 | 1259 | 1042 | 859 | 426 | 177 | 33 | 6114 |
| DES MOINES | 0 | 9 | 99 | 363 | 837 | 1231 | 1398 | 1163 | 967 | 489 | 211 | 39 | 6808 |
| DUBUQUE | 12 | 31 | 156 | 450 | 906 | 1287 | 1420 | 1204 | 1026 | 546 | 260 | 78 | 7376 |
| SIOUX CITY | 0 | 9 | 108 | 369 | 867 | 1240 | 1435 | 1198 | 989 | 483 | 214 | 39 | 6951 |
| WATERLOO | 12 | 19 | 138 | 428 | 909 | 1296 | 1460 | 1221 | 1023 | 531 | 229 | 54 | 7320 |
| KANS. CONCORDIA | 0 | 0 | 57 | 276 | 705 | 1023 | 1163 | 935 | 781 | 372 | 149 | 18 | 5479 |
| DODGE CITY | 0 | 0 | 33 | 251 | 666 | 939 | 1051 | 840 | 719 | 354 | 124 | 9 | 4986 |
| GOODLAND | 0 | 6 | 81 | 381 | 810 | 1073 | 1166 | 955 | 884 | 507 | 236 | 42 | 6141 |
| TOPEKA | 0 | 0 | 57 | 270 | 672 | 980 | 1122 | 893 | 722 | 330 | 124 | 12 | 5182 |
| WICHITA | 0 | 0 | 33 | 229 | 618 | 905 | 1023 | 804 | 645 | 270 | 87 | 6 | 4620 |
| KY. COVINGTON | 0 | 0 | 75 | 291 | 669 | 983 | 1035 | 893 | 756 | 390 | 149 | 24 | 5265 |
| LEXINGTON | 0 | 0 | 54 | 239 | 609 | 902 | 946 | 818 | 685 | 325 | 105 | 0 | 4683 |
| LOUISVILLE | 0 | 0 | 54 | 248 | 609 | 890 | 930 | 818 | 682 | 315 | 105 | 9 | 4660 |
| LA. ALEXANDRIA | 0 | 0 | 0 | 56 | 273 | 431 | 471 | 361 | 260 | 69 | 0 | 0 | 1921 |
| BATON ROUGE | 0 | 0 | 0 | 31 | 216 | 369 | 409 | 294 | 208 | 33 | 0 | 0 | 1560 |
| BURRWOOD | 0 | 0 | 0 | 0 | 96 | 214 | 298 | 218 | 171 | 27 | 0 | 0 | 1024 |
| LAKE CHARLES | 0 | 0 | 0 | 19 | 210 | 341 | 381 | 274 | 195 | 39 | 0 | 0 | 1459 |
| NEW ORLEANS | 0 | 0 | 0 | 19 | 192 | 322 | 363 | 258 | 192 | 39 | 0 | 0 | 1385 |
| SHREVEPORT | 0 | 0 | 0 | 47 | 297 | 477 | 552 | 426 | 304 | 81 | 0 | 0 | 2184 |
| MAINE CARIBOU | 78 | 115 | 336 | 682 | 1044 | 1535 | 1690 | 1470 | 1308 | 858 | 468 | 183 | 9767 |
| PORTLAND | 12 | 53 | 195 | 508 | 807 | 1215 | 1339 | 1182 | 1042 | 675 | 372 | 111 | 7511 |
| MD. BALTIMORE | 0 | 0 | 48 | 264 | 585 | 905 | 936 | 820 | 679 | 327 | 90 | 0 | 4654 |
| FREDERICK | 0 | 0 | 66 | 307 | 624 | 955 | 995 | 876 | 741 | 384 | 127 | 12 | 5087 |
| MASS. BLUE HILL OBSY | 0 | 22 | 108 | 381 | 690 | 1085 | 1178 | 1053 | 936 | 579 | 267 | 69 | 6368 |
| BOSTON | 0 | 9 | 60 | 316 | 603 | 983 | 1088 | 972 | 846 | 513 | 208 | 36 | 5634 |
| NANTUCKET | 2 | 22 | 93 | 332 | 573 | 896 | 992 | 941 | 896 | 621 | 384 | 129 | 5891 |
| PITTSFIELD | 25 | 59 | 219 | 524 | 831 | 1231 | 1339 | 1196 | 1063 | 660 | 326 | 105 | 7578 |
| WORCESTER | 6 | 34 | 147 | 450 | 774 | 1172 | 1271 | 1123 | 998 | 612 | 304 | 78 | 6969 |
| MICH. ALPENA | 68 | 105 | 273 | 580 | 912 | 1268 | 1404 | 1299 | 1218 | 777 | 446 | 156 | 8506 |
| DETROIT (CITY) | 0 | 0 | 87 | 360 | 738 | 1088 | 1181 | 1058 | 936 | 522 | 220 | 42 | 6232 |
| ESCANABA | 59 | 87 | 243 | 539 | 924 | 1293 | 1445 | 1296 | 1203 | 777 | 456 | 159 | 8481 |
| FLINT | 16 | 40 | 159 | 465 | 843 | 1212 | 1330 | 1198 | 1066 | 639 | 319 | 90 | 7377 |
| GRAND RAPIDS | 9 | 28 | 135 | 434 | 804 | 1147 | 1259 | 1134 | 1011 | 579 | 279 | 75 | 6894 |
| LANSING | 6 | 22 | 138 | 431 | 813 | 1163 | 1262 | 1142 | 1011 | 579 | 273 | 69 | 6909 |
| MARQUETTE | 59 | 81 | 240 | 527 | 936 | 1268 | 1411 | 1268 | 1187 | 771 | 468 | 177 | 8393 |
| MUSKEGON | 12 | 28 | 120 | 400 | 762 | 1088 | 1209 | 1100 | 995 | 594 | 310 | 78 | 6696 |
| SAULT STE. MARIE | 96 | 105 | 279 | 580 | 951 | 1367 | 1525 | 1380 | 1277 | 810 | 477 | 201 | 9048 |
| MINN. DULUTH | 71 | 109 | 330 | 632 | 1131 | 1581 | 1745 | 1518 | 1355 | 840 | 490 | 198 | 10000 |
| INT FALLS | 71 | 112 | 363 | 701 | 1236 | 1724 | 1919 | 1621 | 1414 | 828 | 443 | 174 | 10606 |
| MINNEAPOLIS | 22 | 31 | 189 | 505 | 1014 | 1454 | 1631 | 1380 | 1166 | 621 | 288 | 81 | 8382 |
| ROCHESTER | 25 | 34 | 186 | 474 | 1005 | 1438 | 1593 | 1366 | 1150 | 630 | 301 | 93 | 8295 |
| SAINT CLOUD | 28 | 47 | 225 | 549 | 1065 | 1500 | 1702 | 1445 | 1221 | 666 | 326 | 105 | 8879 |

**Normal Total Heating Degree Days (Base 65°)**

| STATE AND STATION | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MISS. JACKSON | 0 | 0 | 0 | 65 | 315 | 502 | 546 | 414 | 310 | 87 | 0 | 0 | 2239 |
| MERIDIAN | 0 | 0 | 0 | 81 | 339 | 518 | 543 | 417 | 310 | 81 | 0 | 0 | 2289 |
| VICKSBURG | 0 | 0 | 0 | 53 | 279 | 462 | 512 | 384 | 282 | 69 | 0 | 0 | 2041 |
| MO. COLUMBIA | 0 | 0 | 54 | 251 | 651 | 967 | 1076 | 874 | 716 | 324 | 121 | 12 | 5046 |
| KANSAS | 0 | 0 | 39 | 220 | 612 | 905 | 1032 | 818 | 682 | 294 | 109 | 0 | 4711 |
| ST. JOSEPH | 0 | 6 | 60 | 285 | 708 | 1039 | 1172 | 949 | 769 | 348 | 133 | 15 | 5484 |
| ST. LOUIS | 0 | 0 | 60 | 251 | 627 | 936 | 1026 | 848 | 704 | 312 | 121 | 15 | 4900 |
| SPRINGFIELD | 0 | 0 | 45 | 223 | 600 | 877 | 973 | 781 | 660 | 291 | 105 | 6 | 4561 |
| MONT. BILLINGS | 6 | 15 | 186 | 487 | 897 | 1135 | 1296 | 1100 | 970 | 570 | 285 | 102 | 7049 |
| GLASGOW | 31 | 47 | 270 | 608 | 1104 | 1466 | 1711 | 1439 | 1187 | 648 | 335 | 150 | 8996 |
| GREAT FALLS | 28 | 53 | 258 | 543 | 921 | 1169 | 1349 | 1154 | 1063 | 642 | 384 | 186 | 7750 |
| HAVRE | 28 | 53 | 306 | 595 | 1065 | 1367 | 1584 | 1364 | 1181 | 657 | 338 | 162 | 8700 |
| HELENA | 31 | 59 | 294 | 601 | 1002 | 1265 | 1438 | 1170 | 1042 | 651 | 381 | 195 | 8129 |
| KALISPELL | 50 | 99 | 321 | 654 | 1020 | 1240 | 1401 | 1134 | 1029 | 639 | 397 | 207 | 8191 |
| MILES CITY | 6 | 6 | 174 | 502 | 972 | 1296 | 1504 | 1252 | 1057 | 579 | 276 | 99 | 7723 |
| MISSOULA | 34 | 74 | 303 | 651 | 1035 | 1287 | 1420 | 1120 | 970 | 621 | 391 | 219 | 8125 |
| NEBR. GRAND ISLAND | 0 | 6 | 108 | 381 | 834 | 1172 | 1314 | 1089 | 908 | 462 | 211 | 45 | 6530 |
| LINCOLN | 0 | 6 | 75 | 301 | 726 | 1066 | 1237 | 1016 | 834 | 402 | 171 | 30 | 5864 |
| NORFOLK | 9 | 0 | 111 | 397 | 873 | 1234 | 1414 | 1179 | 983 | 498 | 233 | 48 | 6979 |
| NORTH PLATTE | 0 | 6 | 123 | 440 | 885 | 1166 | 1271 | 1039 | 930 | 519 | 248 | 57 | 6684 |
| OMAHA | 0 | 12 | 105 | 357 | 828 | 1175 | 1355 | 1126 | 939 | 465 | 208 | 42 | 6612 |
| SCOTTSBLUFF | 0 | 0 | 138 | 459 | 876 | 1128 | 1231 | 1008 | 921 | 552 | 285 | 75 | 6673 |
| VALENTINE | 9 | 12 | 165 | 493 | 942 | 1237 | 1395 | 1176 | 1045 | 579 | 288 | 84 | 7425 |
| NEV. ELKO | 9 | 34 | 225 | 561 | 924 | 1197 | 1314 | 1036 | 911 | 621 | 409 | 192 | 7433 |
| ELY | 28 | 43 | 234 | 592 | 939 | 1184 | 1308 | 1075 | 977 | 672 | 456 | 225 | 7733 |
| LAS VEGAS | 0 | 0 | 0 | 78 | 387 | 617 | 688 | 487 | 335 | 111 | 6 | 0 | 2709 |
| RENO | 43 | 87 | 204 | 490 | 801 | 1026 | 1073 | 823 | 729 | 510 | 357 | 189 | 6332 |
| WINNEMUCCA | 0 | 34 | 210 | 536 | 876 | 1091 | 1172 | 916 | 837 | 573 | 363 | 153 | 6761 |
| N. H. CONCORD | 6 | 50 | 177 | 505 | 822 | 1240 | 1358 | 1184 | 1032 | 636 | 298 | 75 | 7383 |
| MT. WASH. OBSY. | 493 | 536 | 720 | 1057 | 1341 | 1742 | 1820 | 1663 | 1652 | 1260 | 930 | 603 | 13817 |
| N. J. ATLANTIC CITY | 0 | 0 | 39 | 251 | 549 | 880 | 936 | 848 | 741 | 420 | 133 | 15 | 4812 |
| NEWARK | 0 | 0 | 30 | 248 | 573 | 921 | 983 | 876 | 729 | 381 | 118 | 0 | 4859 |
| TRENTON | 0 | 0 | 57 | 264 | 576 | 924 | 989 | 885 | 753 | 399 | 121 | 12 | 4980 |
| N. MEX. ALBUQUERQUE | 0 | 0 | 12 | 229 | 642 | 868 | 930 | 703 | 595 | 288 | 81 | 0 | 4348 |
| CLAYTON | 0 | 6 | 66 | 310 | 699 | 899 | 986 | 812 | 747 | 429 | 183 | 21 | 5158 |
| RATON | 9 | 28 | 126 | 431 | 825 | 1048 | 1116 | 904 | 834 | 543 | 301 | 63 | 6228 |
| ROSWELL | 0 | 0 | 18 | 202 | 573 | 806 | 840 | 641 | 481 | 201 | 31 | 0 | 3793 |
| SILVER CITY | 0 | 0 | 6 | 183 | 525 | 729 | 791 | 605 | 518 | 261 | 87 | 0 | 3705 |
| N. Y. ALBANY | 0 | 19 | 138 | 440 | 777 | 1194 | 1311 | 1156 | 992 | 564 | 239 | 45 | 6875 |
| BINGHAMTON (AP) | 22 | 65 | 201 | 471 | 810 | 1184 | 1277 | 1154 | 1045 | 645 | 313 | 99 | 7286 |
| BINGHAMTON (PO) | 0 | 28 | 141 | 406 | 732 | 1107 | 1190 | 1081 | 949 | 543 | 229 | 45 | 6451 |
| BUFFALO | 19 | 37 | 141 | 440 | 777 | 1156 | 1256 | 1145 | 1039 | 645 | 329 | 78 | 7062 |
| CENTRAL PARK | 0 | 0 | 30 | 233 | 540 | 902 | 986 | 885 | 760 | 408 | 118 | 9 | 4871 |
| J. F. KENNEDY INTL. | 0 | 0 | 36 | 248 | 564 | 933 | 1029 | 935 | 815 | 480 | 167 | 12 | 5219 |
| LAGUARDIA | 0 | 0 | 27 | 223 | 528 | 887 | 973 | 879 | 750 | 414 | 124 | 6 | 4811 |
| ROCHESTER | 9 | 31 | 126 | 415 | 747 | 1125 | 1234 | 1123 | 1014 | 597 | 279 | 48 | 6748 |
| SCHENECTADY | 0 | 22 | 123 | 422 | 756 | 1159 | 1283 | 1131 | 970 | 543 | 211 | 30 | 6650 |
| SYRACUSE | 6 | 28 | 132 | 415 | 744 | 1153 | 1271 | 1140 | 1004 | 570 | 248 | 45 | 6756 |
| N.C. ASHEVILLE | 0 | 0 | 48 | 245 | 555 | 775 | 784 | 683 | 592 | 273 | 87 | 0 | 4042 |
| CAPE HATTERAS | 0 | 0 | 0 | 78 | 273 | 521 | 580 | 518 | 440 | 177 | 25 | 0 | 2612 |
| CHARLOTTE | 0 | 0 | 6 | 124 | 438 | 691 | 691 | 582 | 481 | 156 | 22 | 0 | 3191 |
| GREENSBORO | 0 | 0 | 33 | 192 | 513 | 778 | 784 | 672 | 552 | 234 | 47 | 0 | 3805 |
| RALEIGH | 0 | 0 | 21 | 164 | 450 | 716 | 725 | 616 | 487 | 180 | 34 | 0 | 3393 |
| WILMINGTON | 0 | 0 | 0 | 74 | 291 | 521 | 546 | 462 | 357 | 96 | 0 | 0 | 2347 |
| WINSTON SALEM | 0 | 0 | 21 | 171 | 483 | 747 | 753 | 652 | 524 | 207 | 37 | 0 | 3595 |
| N. DAK. BISMARCK | 34 | 28 | 222 | 577 | 1083 | 1463 | 1708 | 1442 | 1203 | 645 | 329 | 117 | 8851 |
| DEVILS LAKE | 40 | 53 | 273 | 642 | 1191 | 1634 | 1872 | 1579 | 1345 | 753 | 381 | 138 | 9901 |
| FARGO | 28 | 37 | 219 | 574 | 1107 | 1569 | 1789 | 1520 | 1262 | 690 | 332 | 99 | 9226 |
| WILLISTON | 31 | 43 | 261 | 601 | 1122 | 1513 | 1758 | 1473 | 1262 | 681 | 357 | 141 | 9243 |
| OHIO AKRON | 0 | 9 | 96 | 381 | 726 | 1070 | 1138 | 1016 | 871 | 489 | 202 | 39 | 6037 |
| CINCINNATI | 0 | 0 | 54 | 248 | 612 | 921 | 970 | 837 | 701 | 336 | 118 | 9 | 4806 |
| CLEVELAND | 9 | 25 | 105 | 384 | 738 | 1088 | 1159 | 1047 | 918 | 552 | 260 | 66 | 6351 |
| COLUMBUS | 0 | 6 | 84 | 347 | 714 | 1039 | 1088 | 949 | 809 | 426 | 171 | 27 | 5660 |
| DAYTON | 0 | 6 | 78 | 310 | 696 | 1045 | 1097 | 955 | 809 | 429 | 167 | 30 | 5622 |
| MANSFIELD | 9 | 22 | 114 | 397 | 768 | 1110 | 1169 | 1042 | 924 | 543 | 245 | 60 | 6403 |
| SANDUSKY | 0 | 6 | 66 | 313 | 684 | 1032 | 1107 | 991 | 868 | 495 | 198 | 36 | 5796 |
| TOLEDO | 0 | 16 | 117 | 406 | 792 | 1138 | 1200 | 1056 | 924 | 543 | 242 | 60 | 6494 |
| YOUNGSTOWN | 6 | 19 | 120 | 412 | 771 | 1104 | 1169 | 1047 | 921 | 540 | 248 | 60 | 6417 |

Normal Total Heating Degree Days (Base 65°)

| STATE AND STATION | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OKLA. OKLAHOMA CITY | 0 | 0 | 15 | 164 | 498 | 766 | 868 | 664 | 527 | 189 | 34 | 0 | 3725 |
| TULSA | 0 | 0 | 18 | 158 | 522 | 787 | 893 | 683 | 539 | 213 | 47 | 0 | 3860 |
| OREG. ASTORIA | 146 | 130 | 210 | 375 | 561 | 679 | 753 | 622 | 636 | 480 | 363 | 231 | 5186 |
| BURNS | 12 | 37 | 210 | 515 | 867 | 1113 | 1246 | 988 | 856 | 570 | 366 | 177 | 6957 |
| EUGENE | 34 | 34 | 129 | 366 | 585 | 719 | 803 | 627 | 589 | 426 | 279 | 135 | 4726 |
| MEACHAM | 84 | 124 | 288 | 580 | 918 | 1091 | 1209 | 1005 | 983 | 726 | 527 | 339 | 7874 |
| MEDFORD | 0 | 0 | 78 | 372 | 678 | 871 | 918 | 697 | 642 | 432 | 242 | 78 | 5008 |
| PENDLETON | 0 | 0 | 111 | 350 | 711 | 884 | 1017 | 773 | 617 | 396 | 205 | 63 | 5127 |
| PORTLAND | 25 | 28 | 114 | 335 | 597 | 735 | 825 | 644 | 586 | 396 | 245 | 105 | 4635 |
| ROSEBURG | 22 | 16 | 105 | 329 | 567 | 713 | 766 | 608 | 570 | 405 | 267 | 123 | 4491 |
| SALEM | 37 | 31 | 111 | 338 | 594 | 729 | 822 | 647 | 611 | 417 | 273 | 144 | 4754 |
| SEXTON SUMMIT | 81 | 81 | 171 | 443 | 666 | 874 | 958 | 809 | 818 | 609 | 465 | 279 | 6254 |
| PA. ALLENTOWN | 0 | 0 | 90 | 353 | 693 | 1045 | 1116 | 1002 | 849 | 471 | 167 | 24 | 5810 |
| ERIE | 0 | 25 | 102 | 391 | 714 | 1063 | 1169 | 1081 | 973 | 585 | 288 | 60 | 6451 |
| HARRISBURG | 0 | 0 | 63 | 298 | 648 | 992 | 1045 | 907 | 766 | 396 | 124 | 12 | 5251 |
| PHILADELPHIA | 0 | 0 | 60 | 291 | 621 | 964 | 1014 | 890 | 744 | 390 | 115 | 12 | 5101 |
| PITTSBURGH | 0 | 9 | 105 | 375 | 726 | 1063 | 1119 | 1002 | 874 | 480 | 195 | 39 | 5987 |
| READING | 0 | 0 | 54 | 257 | 597 | 939 | 1001 | 885 | 735 | 372 | 105 | 0 | 4945 |
| SCRANTON | 0 | 19 | 132 | 434 | 762 | 1104 | 1156 | 1028 | 893 | 498 | 195 | 33 | 6254 |
| WILLIAMSPORT | 0 | 9 | 111 | 375 | 717 | 1073 | 1122 | 1002 | 856 | 468 | 177 | 24 | 5934 |
| R. I. BLOCK IS. | 0 | 16 | 78 | 307 | 594 | 902 | 1020 | 955 | 877 | 612 | 344 | 99 | 5804 |
| PROVIDENCE | 0 | 16 | 96 | 372 | 660 | 1023 | 1110 | 988 | 868 | 534 | 236 | 51 | 5954 |
| S. C. CHARLESTON | 0 | 0 | 0 | 59 | 282 | 471 | 487 | 389 | 291 | 54 | 0 | 0 | 2033 |
| COLUMBIA | 0 | 0 | 0 | 84 | 345 | 577 | 570 | 470 | 357 | 81 | 0 | 0 | 2484 |
| FLORENCE | 0 | 0 | 0 | 78 | 315 | 552 | 552 | 459 | 347 | 84 | 0 | 0 | 2387 |
| GREENVILLE | 0 | 0 | 0 | 112 | 387 | 636 | 648 | 535 | 434 | 120 | 12 | 0 | 2884 |
| SPARTANBURG | 0 | 0 | 15 | 130 | 417 | 667 | 663 | 560 | 453 | 144 | 25 | 0 | 3074 |
| S. DAK. HURON | 9 | 12 | 165 | 508 | 1014 | 1432 | 1628 | 1355 | 1125 | 600 | 288 | 87 | 8223 |
| RAPID CITY | 22 | 12 | 165 | 481 | 897 | 1172 | 1333 | 1145 | 1051 | 615 | 326 | 126 | 7345 |
| SIOUX FALLS | 19 | 25 | 168 | 462 | 972 | 1361 | 1544 | 1285 | 1082 | 573 | 270 | 78 | 7839 |
| TENN. BRISTOL | 0 | 0 | 51 | 236 | 573 | 828 | 828 | 700 | 598 | 261 | 68 | 0 | 4143 |
| CHATTANOOGA | 0 | 0 | 18 | 143 | 468 | 698 | 722 | 577 | 453 | 150 | 25 | 0 | 3254 |
| KNOXVILLE | 0 | 0 | 30 | 171 | 489 | 725 | 732 | 613 | 493 | 198 | 43 | 0 | 3494 |
| MEMPHIS | 0 | 0 | 18 | 130 | 447 | 698 | 729 | 585 | 456 | 147 | 22 | 0 | 3232 |
| NASHVILLE | 0 | 0 | 30 | 158 | 495 | 732 | 778 | 644 | 512 | 189 | 40 | 0 | 3578 |
| OAK RIDGE (CO) | 0 | 0 | 39 | 192 | 531 | 772 | 778 | 669 | 552 | 228 | 56 | 0 | 3817 |
| TEX. ABILENE | 0 | 0 | 0 | 99 | 366 | 586 | 642 | 470 | 347 | 114 | 0 | 0 | 2624 |
| AMARILLO | 0 | 0 | 18 | 205 | 570 | 797 | 877 | 664 | 546 | 252 | 56 | 0 | 3985 |
| AUSTIN | 0 | 0 | 0 | 31 | 225 | 388 | 468 | 325 | 223 | 51 | 0 | 0 | 1711 |
| BROWNSVILLE | 0 | 0 | 0 | 0 | 66 | 149 | 205 | 106 | 74 | 0 | 0 | 0 | 600 |
| CORPUS CHRISTI | 0 | 0 | 0 | 0 | 120 | 220 | 291 | 174 | 109 | 0 | 0 | 0 | 914 |
| DALLAS | 0 | 0 | 0 | 62 | 321 | 524 | 601 | 440 | 319 | 90 | 6 | 0 | 2363 |
| EL PASO | 0 | 0 | 0 | 84 | 414 | 648 | 685 | 445 | 319 | 105 | 0 | 0 | 2700 |
| FORT WORTH | 0 | 0 | 0 | 65 | 324 | 536 | 614 | 448 | 319 | 99 | 0 | 0 | 2405 |
| GALVESTON | 0 | 0 | 0 | 0 | 138 | 270 | 350 | 258 | 189 | 30 | 0 | 0 | 1235 |
| HOUSTON | 0 | 0 | 0 | 6 | 183 | 307 | 384 | 288 | 192 | 36 | 0 | 0 | 1396 |
| LAREDO | 0 | 0 | 0 | 0 | 105 | 217 | 267 | 134 | 74 | 0 | 0 | 0 | 797 |
| LUBBOCK | 0 | 0 | 18 | 174 | 513 | 744 | 800 | 613 | 484 | 201 | 31 | 0 | 3578 |
| MIDLAND | 0 | 0 | 0 | 87 | 381 | 592 | 651 | 468 | 322 | 90 | 0 | 0 | 2591 |
| PORT ARTHUR | 0 | 0 | 0 | 22 | 207 | 329 | 384 | 274 | 192 | 39 | 0 | 0 | 1447 |
| SAN ANGELO | 0 | 0 | 0 | 68 | 318 | 536 | 567 | 412 | 288 | 66 | 0 | 0 | 2255 |
| SAN ANTONIO | 0 | 0 | 0 | 31 | 207 | 363 | 428 | 286 | 195 | 39 | 0 | 0 | 1549 |
| VICTORIA | 0 | 0 | 0 | 6 | 150 | 270 | 344 | 230 | 152 | 21 | 0 | 0 | 1173 |
| WACO | 0 | 0 | 0 | 43 | 270 | 456 | 536 | 389 | 270 | 66 | 0 | 0 | 2030 |
| WICHITA FALLS | 0 | 0 | 0 | 99 | 381 | 632 | 698 | 518 | 378 | 120 | 6 | 0 | 2832 |
| UTAH MILFORD | 0 | 0 | 99 | 443 | 867 | 1141 | 1252 | 988 | 822 | 519 | 279 | 87 | 6497 |
| SALT LAKE CITY | 0 | 0 | 81 | 419 | 849 | 1082 | 1172 | 910 | 763 | 459 | 233 | 84 | 6052 |
| WENDOVER | 0 | 0 | 48 | 372 | 822 | 1091 | 1178 | 902 | 729 | 408 | 177 | 51 | 5778 |
| VT. BURLINGTON | 28 | 65 | 207 | 539 | 891 | 1349 | 1513 | 1333 | 1187 | 714 | 353 | 90 | 8269 |
| VA. CAPE HENRY | 0 | 0 | 0 | 112 | 360 | 645 | 694 | 633 | 536 | 246 | 53 | 0 | 3279 |
| LYNCHBURG | 0 | 0 | 51 | 223 | 540 | 822 | 849 | 731 | 605 | 267 | 78 | 0 | 4166 |
| NORFOLK | 0 | 0 | 0 | 136 | 408 | 698 | 738 | 655 | 533 | 216 | 37 | 0 | 3421 |
| RICHMOND | 0 | 0 | 36 | 214 | 495 | 784 | 815 | 703 | 546 | 219 | 53 | 0 | 3865 |
| ROANOKE | 0 | 0 | 51 | 229 | 549 | 825 | 834 | 722 | 614 | 261 | 65 | 0 | 4150 |
| WASH NAT AP | 0 | 0 | 33 | 217 | 519 | 834 | 871 | 762 | 626 | 288 | 74 | 0 | 4224 |

**Normal Total Heating Degree Days (Base 65°)**

| STATE AND STATION | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WASH. OLYMPIA | 68 | 71 | 198 | 422 | 636 | 753 | 834 | 675 | 645 | 450 | 307 | 177 | 5236 |
| SEATTLE | 50 | 47 | 129 | 329 | 543 | 657 | 738 | 599 | 577 | 396 | 242 | 117 | 4424 |
| SEATTLE BOEING | 34 | 40 | 147 | 384 | 624 | 763 | 831 | 655 | 608 | 411 | 242 | 99 | 4838 |
| SEATTLE TACOMA | 56 | 62 | 162 | 391 | 633 | 750 | 828 | 678 | 657 | 474 | 295 | 159 | 5145 |
| SPOKANE | 9 | 25 | 168 | 493 | 879 | 1082 | 1231 | 980 | 834 | 531 | 288 | 135 | 6655 |
| STAMPEDE PASS | 273 | 291 | 393 | 701 | 1008 | 1178 | 1287 | 1075 | 1085 | 855 | 654 | 483 | 9283 |
| TATOOSH IS. | 295 | 279 | 306 | 406 | 534 | 639 | 713 | 613 | 645 | 525 | 431 | 333 | 5719 |
| WALLA WALLA | 0 | 0 | 87 | 310 | 681 | 843 | 986 | 745 | 589 | 342 | 177 | 45 | 4805 |
| YAKIMA | 0 | 12 | 144 | 450 | 828 | 1039 | 1163 | 868 | 713 | 435 | 220 | 69 | 5941 |
| W. VA. CHARLESTON | 0 | 0 | 63 | 254 | 591 | 865 | 880 | 770 | 648 | 300 | 96 | 9 | 4476 |
| ELKINS | 9 | 25 | 135 | 400 | 729 | 992 | 1008 | 896 | 791 | 444 | 198 | 48 | 5675 |
| HUNTINGTON | 0 | 0 | 63 | 257 | 585 | 856 | 880 | 764 | 636 | 294 | 99 | 12 | 4446 |
| PARKERSBURG | 0 | 0 | 60 | 264 | 606 | 905 | 942 | 826 | 691 | 339 | 115 | 6 | 4754 |
| WIS. GREEN BAY | 28 | 50 | 174 | 484 | 924 | 1333 | 1494 | 1313 | 1141 | 654 | 335 | 99 | 8029 |
| LA CROSSE | 12 | 19 | 153 | 437 | 924 | 1339 | 1504 | 1277 | 1070 | 540 | 245 | 69 | 7589 |
| MADISON | 25 | 40 | 174 | 474 | 930 | 1330 | 1473 | 1274 | 1113 | 618 | 310 | 102 | 7863 |
| MILWAUKEE | 43 | 47 | 174 | 471 | 876 | 1252 | 1376 | 1193 | 1054 | 642 | 372 | 135 | 7635 |
| WYO. CASPER | 6 | 16 | 192 | 524 | 942 | 1169 | 1290 | 1084 | 1020 | 657 | 381 | 129 | 7410 |
| CHEYENNE | 19 | 31 | 210 | 543 | 924 | 1101 | 1228 | 1056 | 1011 | 672 | 381 | 102 | 7278 |
| LANDER | 6 | 19 | 204 | 555 | 1020 | 1299 | 1417 | 1145 | 1017 | 654 | 381 | 153 | 7870 |
| SHERIAN | 25 | 31 | 219 | 539 | 948 | 1200 | 1355 | 1154 | 1054 | 642 | 366 | 150 | 7683 |

One of the most practical of weather statistics is the "heating degree day." First devised some 50 years ago, the degree day system has been in quite general use by the heating industry for more than 30 years.

Heating degree days are the number of degrees the daily average tempertaure is below 65°. Normally heating is not required in a building when the outdoor average daily temperature is 65°. Heating degree days are determined by substracting the average daily temperatures below 65° from the base 65°. A day with an average temperature of 50° has 15 heating degree days (65 − 50 = 15) while one with an average temperature of 65° or higher has none.

Several characteristics make the degree day figures especially useful. They are cumulative so that the degree day sum for a period of days represents the total heating load for that period. The relationship between degree days and fuel consumption is linear, i.e., doubling the degree days usually doubles the fuel consumption. Comparing normal seasonal degree days in different locations gives a rough estimate of seasonal fuel consumption. For example, it would require roughly 4½ times as much fuel to heat a building in Chicago, Ill., where the mean annual total heating degree days are about 6,200 than to heat a similar building in New Orleans, La., where the annual total heating degree days are around 1,400. Using degree days has the advantage that the consumption ratios are fairly constant, i.e., the fuel consumed per 100 degree days is about the same whether the 100 degree days occur in only 3 or 4 days or are spread over 7 or 8 days.

The rapid adoption of the degree day system paralleled the spread of automatic fuel systems in the 1930's. Since oil and gas are more costly to store than solid fuels, this places a premium on the scheduling of deliveries and the precise evaluation of use rates and peak demands.

# PROTECTING YOUR POCKETBOOK

If there is one characteristic consumers have in common, it is the desire to get one's money's worth on a commercial transaction. In the solar field, there are three main obstacles in satisfying this all-important objective:

1. The consumer's own lack of knowledge and inexperience in this field.
2. Manufacturers who unintentionally build shoddy products and who are too overenthusiastic about their products.
3. Deliberate fraud and misrepresentation.

The best weapon against all three is for the consumer to recognize his or her own limitations and to rely upon competent engineering counsel. "Knowing that one does not know" is the first step toward wisdom, as one old philosopher said.

Though the purpose of this book is to give you some basic guidelines in buying solar, it is not all conclusive. Beyond these guidelines presented herein, and the need for proper engineering counsel, here are some other steps you can take to insure that you get your money's worth in a solar system:

- *Ask for proof that the product will perform as advertised.* The proof could come from an independent laboratory or a university. You should have the report itself, not what the manufacturer states the report claims. Have your engineering consultant go over the report.

- *Examine the warranty carefully.* Remember that according to the law, the manufacturer must state that the warranty is full or limited. If it is limited, know what the limitations are. How long does the warranty last? Are parts, service, and labor covered? Who will provide the service? Does the equipment have to be sent back to the manufacturer for repairs? Make sure you understand the terms of the warranty before you buy. Ask the seller what financial arrangements, such as an escrow account, have been made to honor the warranties. Be sure your engineering counsel not only looks over the warranty, but the design itself to determine whether there are any important omissions.

- *Solar components are like stereo components—some work well together, others don't.* If the system you are purchasing is not sold as a single package by one manufacturer, then you should obtain assurance that the seller has had the professional experience of choosing properly.

- *Ask the man or woman who owns one.* Ask the seller for a list of previous purchasers and their addresses, and then ask the owners about their experiences.

- *Be careful of sellers who use Post Office Box numbers.* Though many legitimate businesses use these outlets as a convenient way to receive bills and orders, a common tactic of the fly-by-night artist is to use a Post Office Box number, operate a territory until the law starts closing in, then move and take a new name in a new territory. Find out from the seller where his place of business is, how long he has been there, and ask for his financial references.

- *Be sure you will know specifically who will service the solar syst[illegible]ething goes wrong.* Don't settle for [illegible]sponse that any plumber or handyman will do.

- *Don't try a do-it-yourself kit, unless you really have a very solid background as a handyman.* One or two mistakes could make a system inoperable and you will have no one to blame but yourself.

- *Remember that what counts with a solar system is the amount of Btu's delivered for the final end use of the system, and that this amount can fluctuate widely.* A very good winter with much sunshine can produce performance levels beyond the manufacturer's projections. Conversely, an unusually bad winter with heavy cloud covers could make the projections drop dramatically. The seller will be working from historical averages. A good guide to performance is whether the season is typical or atypical. If it is typical, and your energy use patterns haven't changed, then the savings projections may have been inaccurate.

- *Don't change your use habits simply because you are getting plenty of free energy.* Conservation of energy still counts if you want to bring your monthly b[illegible] down. Don't blame the seller of a solar heating system if you keep your doors open during the middle of wintertime.

- *Don't forget your local consumer office or your Better Business Bureau.* Both may be able to help you determine whether a seller is reputable or not. Check, too, to see whether there is a local volunteer citizens solar organization around. If so, it can probably give you plenty of good advice.

- *If the seller makes verbal claims that are not reflected in the literature handed out, ask him to write those claims down, and to sign his name to it.* Compare what he said with what he wrote. Save that statement.

- *If you have what appears to be a legitimate complaint, notify the local district attorney's office immediately, the Better Business Bureau, and the local consumer protection agency.* Be as specific in your complaint as possible, and give as much documentation as you can.

# ANSWERS TO QUESTIONS YOU ALWAYS WANTED TO ASK

Q: Supposing I move out of the house in a year or two. Can I count on appreciation?

A: It depends on two basic factors: if it looks good and if it saves sufficient energy purchases. You should be able to prove whether it works or not in cases of retrofit simply by saving your energy bills, and comparing conventional fuel usage with past bill statements. In cases of new homes, comparisons of operating costs for solar versus conventional homes can be helpful, but not conclusive because of large differences in heat use by different families even in identical homes. Year-to-year differences may also be large, so a call to your energy supplier (gas or electric company or oil supplier) can be helpful in establishing what the relative energy use should have been.

As to eye appeal, that's something else. If it looks good to you and your neighbors, the odds for appreciation are in your favor. But remember, it's the buyer's eye that counts the most.

Q: If I plan on a heating system, should I allow for extra space for storage and collector so that I can later adapt to a cooling unit?

A: Ask your engineering consultant what these extra costs amount to for your particular design. If you are building a new home, and plan to live in it for some time, it will probably be easier to plan now for a cooling system, rather than retrofit later.

Q: Should I buy now or later when improvements in solar technology are sure to take place?

A: There is no doubt that later solar systems will have improvements over present models, and there will not be as much risk for the buyer as there is today. However, costs for tomorrow's solar systems may go higher, and you lose all the money you could have saved from not using expensive conventional fuels. There's something to be said, too, about being a pioneer.

Q: Will I need a humidifier with my solar system?

A: Fundamentally, a solar system replaces "conventional" energy with solar energy. It does not necessarily have any effect upon the need for a humidifier. Many solar systems use a hot water tank for energy storage and the hot water tank may be located within the structure. Generally, if this is the case, the tank should be covered and sealed so that water vapor (humidity) does not escape from the tank into your house in the summertime when it is not wanted. An uncovered tank would help humidify the air in your house in the winter but the "price" paid because of excessive humidity in the summer is generally too high.

Q: How can I contact a reliable solar engineer?

A: One of your best bets is to call a local engineering university and ask to speak to one of the professors about solar energy. Tell the professor you want to hire an advisor who is knowledgeable in the area. Generally, these instructors have a good idea of who is good in a local community. Failing that, contact one of the local engineering societies (such as the American Institute of Architects, the Society of Mechanical Engineers, or the American Society of Heating, Refrigeration, and Air Conditioning Engineers) and ask for a list of engineers who are knowledgeable about solar. When you make contact with those who are on the list, ask for references as to their previous work in the field.

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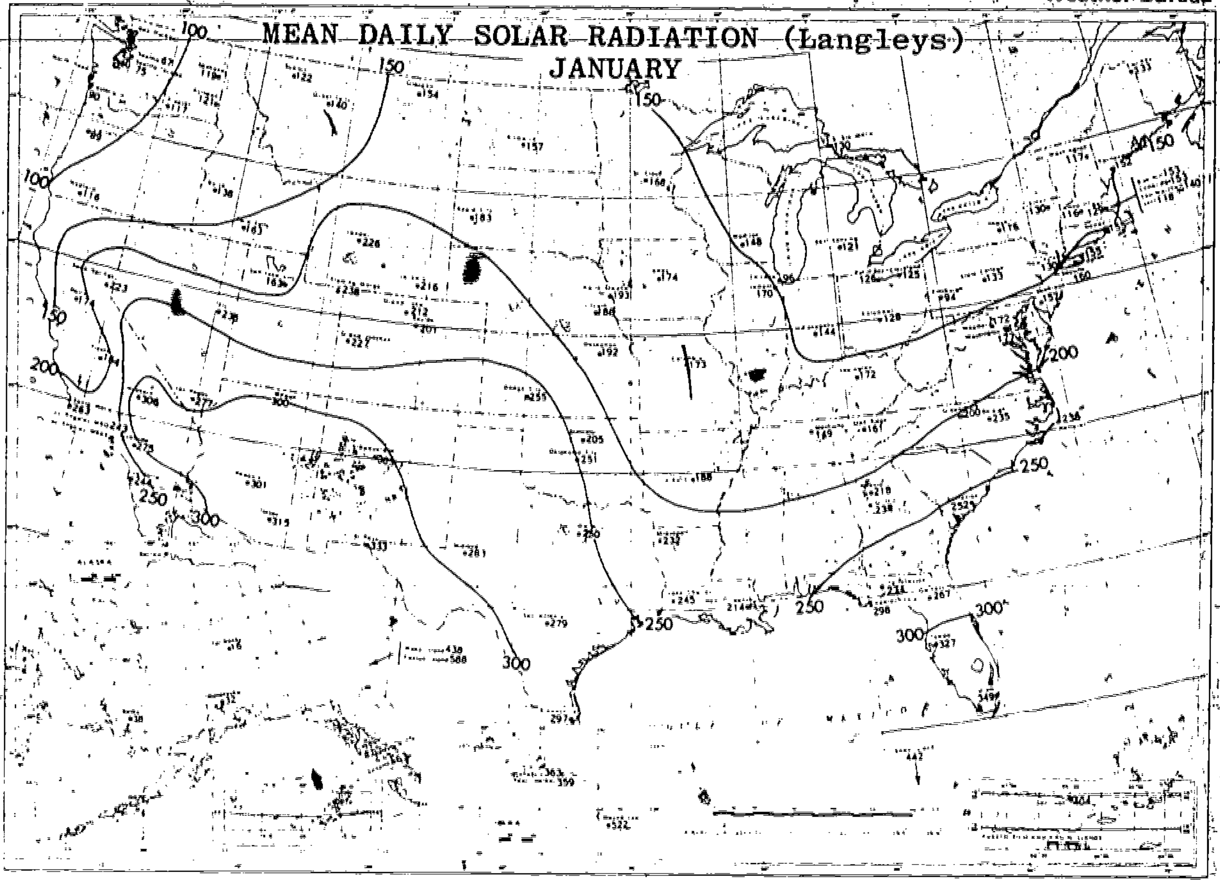
## Mean Daily Solar Radiation, Monthly and Annual

U.S. Department of Commerce Weather Bureau



MEAN DAILY SOLAR RADIATION (Langleys)
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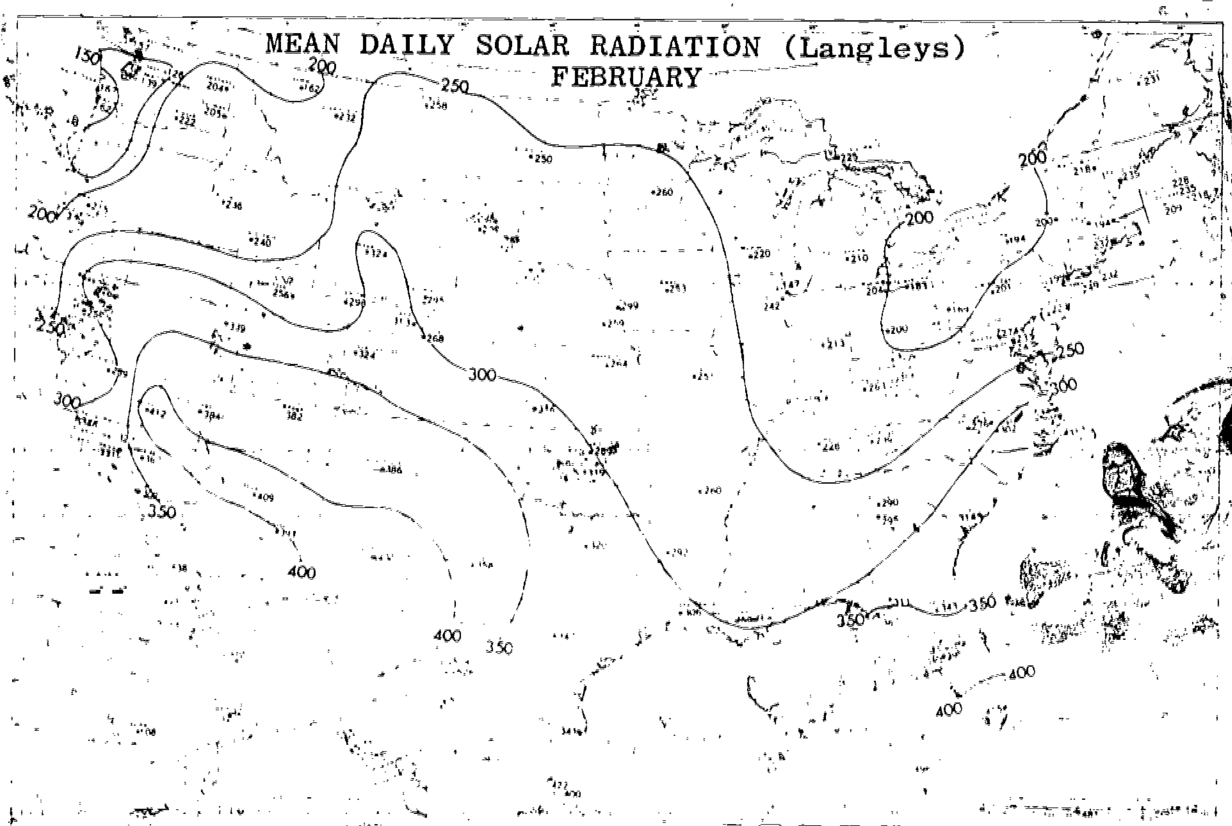
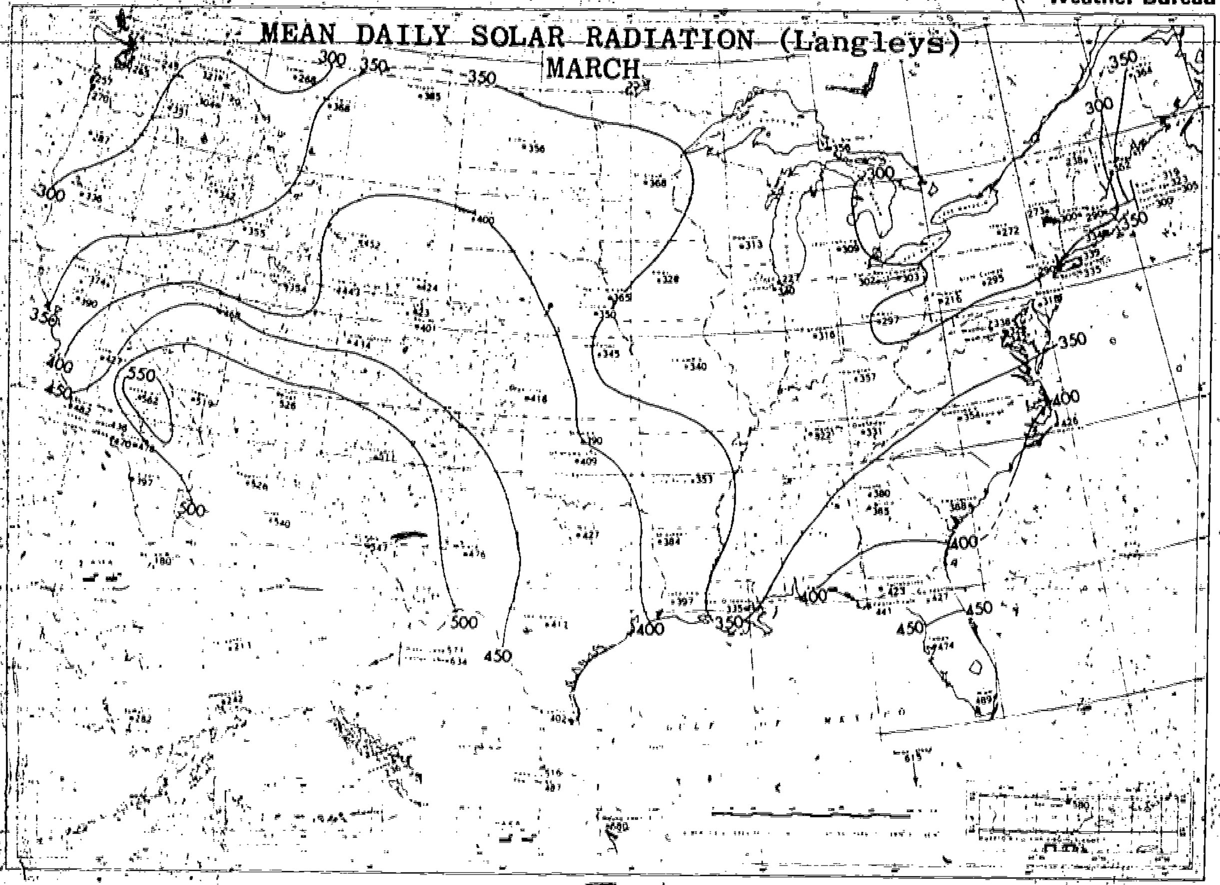
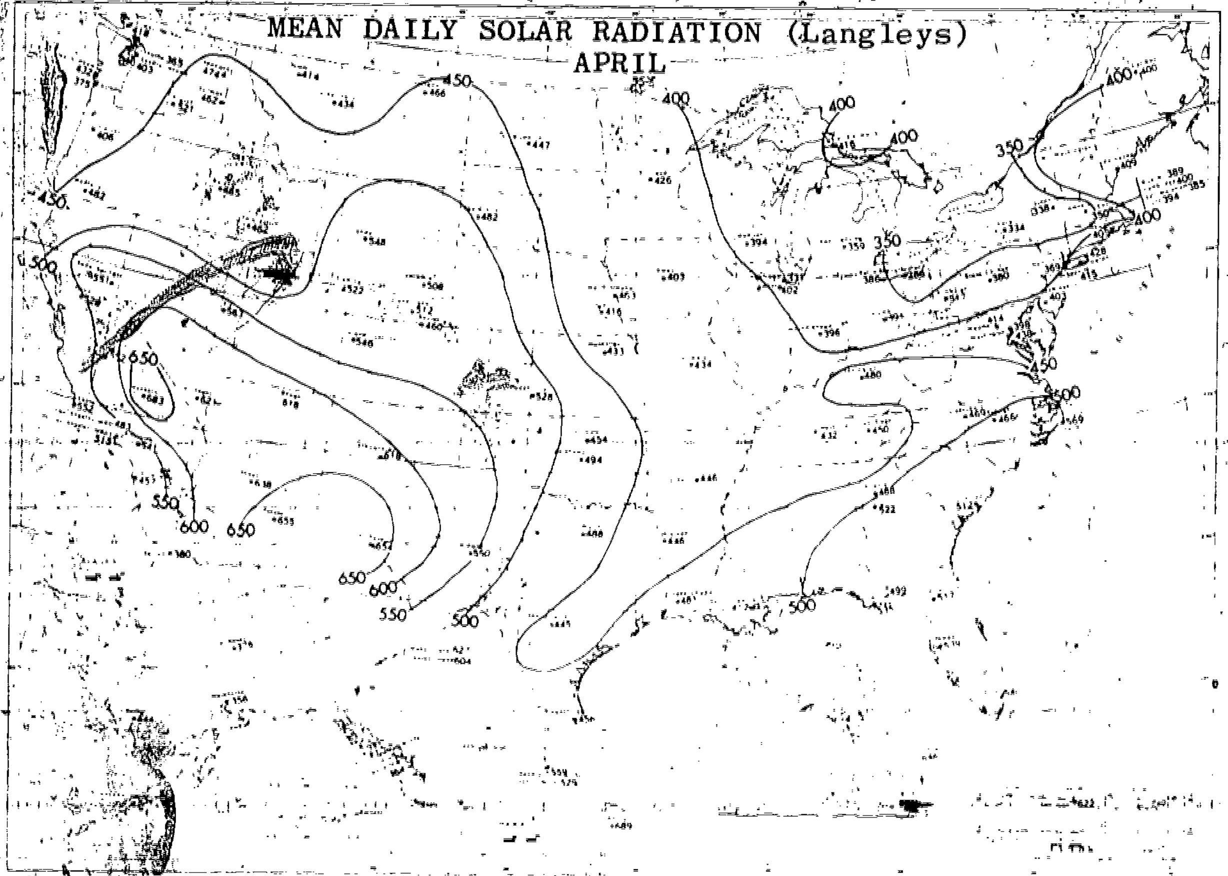


MEAN DAILY SOLAR RADIATION (Langleys)
FEBRUARY

**Mean Daily Solar Radiation, Monthly and Annual**

**U.S. Department of Commerce** **Weather Bureau**





## Mean Daily Solar Radiation Monthly and Annual

U.S. Department of Commerce

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**Mean Daily Solar Radiation, Monthly and Annual**

U.S. Department of Commerce

MEAN DAILY SOLAR RADIATION (Langleys)
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**Mean Daily Solar Radiation, Monthly and Annual**

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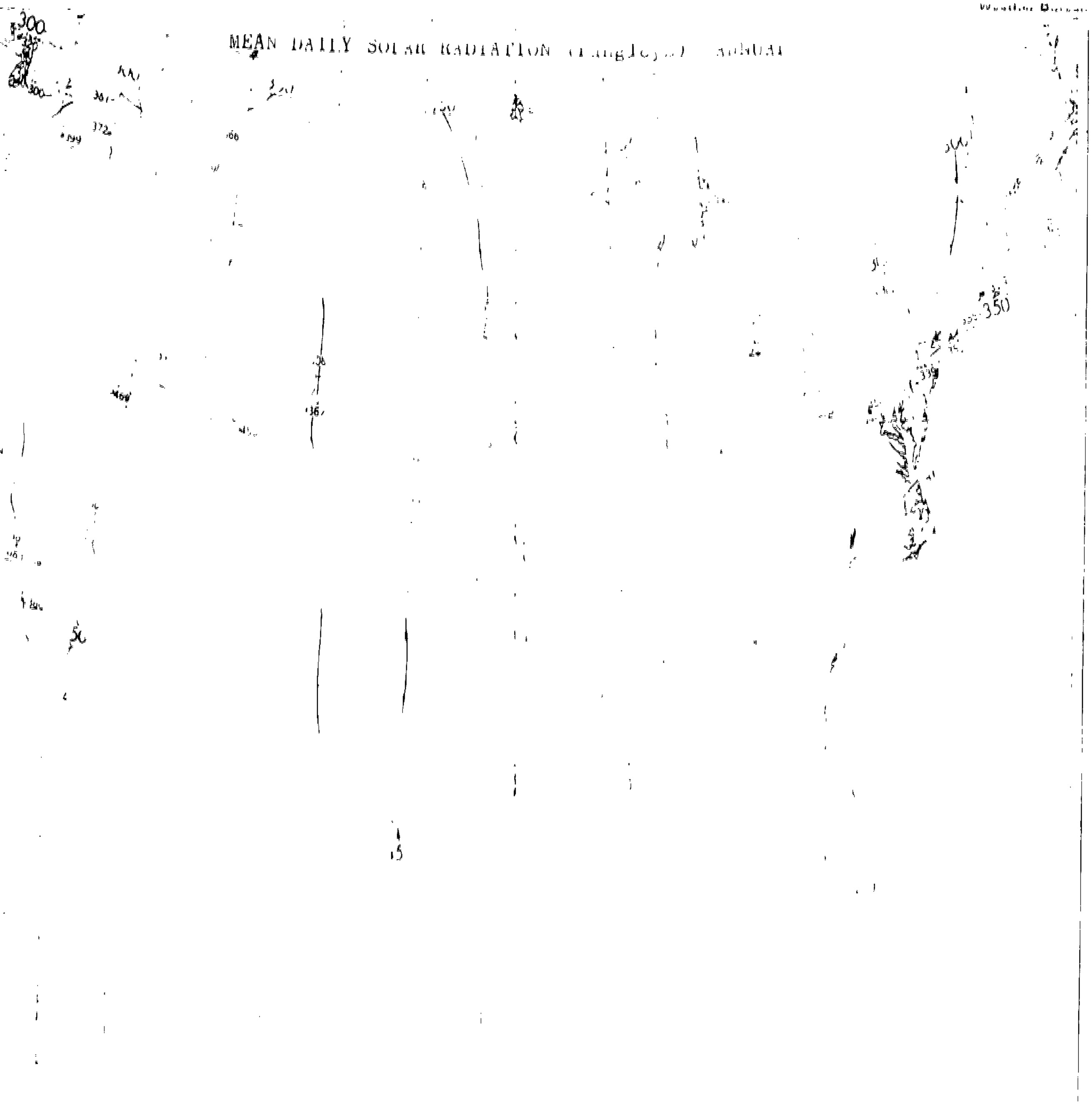
# MEAN DAILY SOLAR RADIATION (langleys) ANNUAL



Mean Daily Solar Radiation (Langleys) and Years of Record Used

| STATES AND STATIONS | JAN | YRS | FEB | YRS | MAR | YRS | APR | YRS | MAY | YRS | JUNE | YRS | JULY | YRS | AUG | YRS | SEPT | YRS | OCT | YRS | NOV | YRS | DEC | YRS | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA Annette | 63 | 6 | 115 | 6 | 236 | 7 | 364 | 7 | 437 | 6 | 438 | 6 | 438 | 6 | 341 | 6 | 258 | 7 | 122 | 7 | 59 | 7 | 41 | 7 | 243 |
| Barrow | * | | 38 | 8 | 180 | 8 | 380 | 8 | 513 | 8 | 528 | 8 | 429 | 9 | 255 | 10 | 115 | 10 | 41 | 10 | * | | [illegible] | | 206 |
| Bethel | 38 | 9 | 108 | 10 | 282 | 9 | 444 | 10 | 457 | 10 | 454 | 10 | 376 | 10 | 252 | 10 | 202 | 10 | 115 | 10 | 44 | [illegible] | 22 | [illegible] | 233 |
| Fairbanks | 16 | 25 | 71 | 27 | 213 | 25 | 376 | 28 | 461 | 28 | 504 | 29 | 434 | 28 | 317 | 29 | 180 | 29 | 82 | 30 | 26 | [illegible] | [illegible] | [illegible] | 224 |
| Matanuska | 32 | 6 | 92 | 6 | 242 | 4 | 356 | 7 | 436 | 7 | 462 | 6 | 409 | 6 | 314 | 6 | 198 | 6 | 100 | 6 | 38 | 6 | 15 | 7 | 224 |
| ARIZ. Page | 300 | 2 | 382 | 3 | 526 | 3 | 618 | 2 | 695 | 2 | 707 | 2 | 680 | 3 | 596 | 3 | 516 | 3 | 402 | 3 | 10 | 3 | 43 | 3 | 498 |
| Phoenix | 301 | 11 | 409 | 11 | 526 | 11 | 638 | 11 | 724 | 11 | 739 | 11 | 658 | 11 | 613 | 11 | 566 | 11 | 449 | 11 | 344 | 11 | 281 | 11 | 520 |
| Tucson | 315 | 5 | 391 | 5 | 540 | 4 | 655 | 5 | 729 | 5 | 699 | 5 | 626 | 6 | 588 | 6 | 570 | 6 | 442 | 6 | 356 | 6 | 305 | 6 | 518 |
| ARK. Little [illegible] | 168 | 9 | 260 | 9 | 353 | 10 | 446 | 9 | 523 | 9 | 559 | 9 | 556 | 8 | 518 | 9 | 439 | 7 | 343 | 8 | 244 | 10 | 187 | 10 | 385 |
| CALIFORNIA Davis | 174 | 18 | 257 | 17 | 390 | 18 | 528 | 18 | 625 | 18 | 694 | 18 | 682 | 18 | 612 | 18 | 493 | 18 | 347 | 19 | 222 | 19 | 148 | 19 | 411 |
| Fresno | 184 | 31 | 289 | 31 | 427 | 31 | 552 | 31 | 647 | 31 | 702 | 32 | 682 | 32 | 621 | 31 | 510 | 31 | 376 | 32 | 250 | 31 | 161 | 32 | 450 |
| Inyokern [illegible] | 306 | 11 | 412 | 11 | 562 | 11 | 683 | 11 | 772 | 11 | 819 | 11 | 772 | 11 | 729 | 10 | 635 | 8 | 467 | 9 | 363 | 11 | 300 | 12 | 568 |
| LaJolla | 244 | 19 | 302 | 18 | 397 | 19 | 457 | 20 | 506 | 19 | 487 | 21 | 497 | 22 | 464 | 22 | 389 | 22 | 320 | 21 | 277 | 20 | 221 | 20 | 380 |
| Los Angeles WBAS | 248 | 10 | 331 | 10 | 470 | 10 | 515 | 10 | 572 | 9 | 596 | 9 | 641 | 9 | 581 | 10 | 503 | 10 | 373 | 10 | 289 | 10 | 241 | 10 | 463 |
| Los Angeles WBO | 243 | 9 | 327 | 9 | 436 | 9 | 483 | 9 | 555 | 9 | 584 | 9 | 651 | 9 | 581 | 10 | 500 | 10 | 362 | 10 | 281 | 10 | 234 | 10 | 436 |
| Riverside | 275 | 8 | 367 | 8 | 478 | 9 | 541 | 9 | 623 | 9 | 680 | 9 | 673 | 9 | 618 | 9 | 535 | 9 | 407 | 9 | 319 | 9 | 270 | 9 | 483 |
| Santa Maria | 263 | 11 | 346 | 11 | 482 | 11 | 552 | 10 | 635 | 11 | 694 | 11 | 680 | 11 | 613 | 11 | 524 | 11 | 419 | 11 | 313 | 11 | 252 | 11 | 481 |
| Soda Springs | 223 | 4 | 316 | 4 | 374 | 4 | 551 | 4 | 615 | 3 | 691 | 4 | 760 | 3 | 681 | 3 | 510 | 3 | 357 | 4 | 248 | 4 | 182 | 4 | 455 |
| COLO. Boulder | 201 | 5 | 268 | 4 | 401 | 4 | 460 | 4 | 460 | 4 | 525 | 5 | 520 | 5 | 439 | 5 | 412 | 4 | 310 | 4 | 222 | 4 | 182 | 4 | [illegible] |
| Grand Junction | 227 | 9 | 324 | 9 | 434 | 8 | 546 | 8 | 615 | 9 | 708 | 8 | 676 | 8 | 595 | 8 | 514 | 8 | 373 | [illegible] | 260 | [illegible] | 212 | [illegible] | 456 |
| Grand Lake [illegible] | 212 | 6 | 313 | 7 | 423 | 7 | 512 | 8 | 552 | 8 | 632 | 8 | 600 | 8 | 505 | 7 | 476 | 6 | 361 | 7 | 234 | 6 | 184 | 7 | 417 |
| D.C. Washington | 174 | [illegible] | 266 | 3 | 344 | 2 | 411 | 2 | 551 | 2 | 494 | 2 | 536 | 2 | 446 | 3 | 375 | 3 | 299 | 3 | 211 | 3 | 166 | [illegible] | 356 |
| American University | 158 | 9 | 231 | 9 | 322 | 9 | 398 | 9 | 467 | 9 | 510 | 9 | 496 | 9 | 440 | 8 | 364 | 8 | 278 | 8 | 192 | 9 | 141 | 9 | 333 |
| Silver Hill | 177 | 7 | 247 | 8 | 342 | 7 | 438 | 7 | 513 | 7 | 555 | 7 | 511 | 7 | 457 | 7 | 391 | 6 | 293 | 8 | 202 | 7 | 156 | 6 | 357 |
| FLA. Apalachicola | 298 | 10 | 367 | 10 | 441 | 10 | 535 | 10 | 603 | 9 | 578 | 9 | 529 | 9 | 511 | 9 | 456 | 9 | 413 | 10 | 332 | 10 | 262 | 10 | 444 |
| Belle Isle | 297 | 10 | 330 | 10 | 412 | 10 | 463 | 10 | 483 | 10 | 464 | 10 | 488 | 11 | 461 | 10 | 400 | 10 | 366 | 11 | 313 | 11 | 291 | 10 | 397 |
| Gainesville | 267 | 11 | 343 | 10 | 427 | 12 | 517 | 12 | 579 | 12 | 521 | 10 | 488 | 10 | 483 | 8 | 418 | 9 | 347 | 8 | 300 | 10 | 233 | 10 | 410 |
| Miami Airport | 349 | 10 | 415 | 9 | 489 | 9 | 540 | 10 | 553 | 10 | 532 | 10 | 532 | 10 | 505 | 10 | 440 | 10 | 384 | 10 | 353 | 10 | 316 | 10 | 451 |
| Tallahassee | 274 | 2 | 311 | 2 | 423 | 3 | 499 | 3 | 547 | 3 | 521 | 3 | 508 | 3 | 542 | 2 | * | | * | | 292 | 2 | 230 | 2 | |
| Tampa | 327 | 8 | 391 | 8 | 474 | 8 | 539 | 8 | 596 | 8 | 574 | 9 | 534 | 9 | 494 | 9 | 45[illegible] | 9 | [illegible] | 9 | 356 | 8 | 300 | 9 | [illegible] |
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| Griffin | 234 | 9 | 295 | 9 | 385 | 10 | 522 | 11 | 570 | 11 | 577 | 11 | 556 | 11 | 522 | 11 | 435 | 11 | 368 | 11 | 283 | 11 | 201 | 11 | [illegible] |
| HAWAII H[illegible] | 363 | 4 | 422 | 4 | 516 | 4 | 559 | 5 | 617 | 5 | 615 | 5 | 615 | 5 | 612 | 5 | 573 | 5 | 507 | 5 | 426 | 3 | 371 | 5 | 516 |
| Mauna Loa [illegible] | 522 | 2 | 576 | 2 | 680 | 2 | 689 | 3 | 727 | 3 | * | | 703 | 3 | 642 | 2 | 602 | 2 | 560 | 2 | 504 | 2 | 481 | 3 | |
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| IDAHO Boise | 138 | 10 | 236 | 9 | 342 | 9 | 485 | 9 | 585 | 10 | 636 | 9 | 670 | 10 | 576 | 10 | 460 | 10 | 301 | 11 | 182 | 11 | 124 | 11 | 395 |
| Twin Falls | 163 | [illegible] | 240 | [illegible] | 355 | [illegible] | 462 | [illegible] | 552 | 20 | 592 | 8 | 602 | 20 | 540 | 20 | 432 | 19 | 286 | 20 | 176 | 20 | 131 | 19 | 378 |
| ILL. Chicago | [illegible] | 19 | 147 | 19 | 227 | 19 | 331 | 19 | 424 | 19 | 458 | 18 | 473 | 19 | 403 | 18 | 313 | 19 | 207 | 20 | 120 | 20 | 76 | 20 | 273 |
| Lemont | 170 | 6 | 242 | 6 | 340 | 6 | 402 | 6 | 506 | 6 | 553 | 6 | 540 | 6 | 498 | 6 | 398 | 5 | 275 | 5 | 165 | 5 | 138 | 5 | 352 |
| IND. Indianapolis | 144 | 10 | 213 | 10 | 316 | 10 | 396 | 10 | 488 | 9 | 543 | 11 | 541 | 10 | 490 | 11 | 405 | 11 | 293 | 11 | 177 | 11 | 132 | 11 | [illegible] |
| IOWA Ames | 174 | 5 | 253 | 5 | 326 | 5 | 403 | 5 | 480 | 5 | 541 | 5 | 436 | 6 | 460 | 6 | 367 | 6 | 274 | 7 | 187 | 7 | 143 | 7 | 315 |
| KANS. Dodge [illegible] | 255 | 7 | 316 | 7 | 418 | 7 | 528 | 7 | 568 | 7 | 650 | 7 | 642 | 8 | 592 | 9 | 493 | 9 | 380 | 9 | 285 | 10 | 234 | 10 | 447 |
| Manhattan | 192 | 3 | 264 | 3 | 345 | 3 | 433 | 3 | 527 | 4 | 551 | 4 | 531 | 4 | 526 | 4 | 410 | 4 | 292 | 4 | 227 | 4 | 156 | 4 | 371 |
| KY. Lexington | 172 | 9 | 263 | 9 | 357 | 10 | 480 | 10 | 581 | 10 | 628 | 9 | 617 | 10 | 563 | 10 | 494 | 10 | 357 | 9 | 245 | 9 | 174 | 11 | 411 |
| LA. Lake Charles | 245 | 11 | 306 | 11 | 397 | 11 | 481 | 11 | 555 | 11 | 591 | 11 | 526 | 11 | 511 | 11 | 449 | 11 | 402 | 11 | 300 | 10 | 250 | 10 | 418 |
| New Orleans | 214 | 11 | 259 | 14 | 335 | 15 | 412 | 16 | 449 | 14 | 443 | 13 | 417 | 15 | 416 | 15 | 383 | 15 | 357 | 13 | 278 | 13 | 198 | 14 | 347 |
| Shreveport | 232 | 4 | 292 | 4 | 384 | 4 | 446 | 4 | 558 | 4 | 557 | 4 | 578 | 4 | 528 | 4 | 444 | 4 | 354 | 4 | 254 | 4 | 205 | 4 | 406 |
| MAINE Caribou | 133 | 8 | 231 | 9 | 361 | 8 | 400 | 10 | 476 | 10 | 470 | 10 | 508 | 11 | 448 | 11 | 336 | 11 | 212 | 11 | 111 | 11 | 107 | 9 | 316 |
| Portland | 152 | 7 | 215 | 8 | 352 | 7 | 409 | 8 | 514 | 9 | 539 | 9 | 561 | 9 | 488 | 8 | 383 | 7 | 278 | 9 | 157 | 8 | 137 | 9 | 350 |
| MASS. Amherst | 116 | 2 | * | | 300 | 2 | * | | 411 | 2 | 514 | 2 | * | | | | | | | | 152 | 2 | 121 | 2 | |
| Blue Hill | 151 | 7 | [illegible] | [illegible] | 319 | 8 | [illegible] | 6 | 469 | 7 | 510 | 7 | [illegible] | | 449 | | [illegible] | | [illegible] | | 162 | 8 | 135 | 8 | 326 |
| Boston | 129 | 6 | 194 | 7 | 290 | 7 | [illegible] | 17 | 445 | 16 | 483 | 16 | 486 | 16 | 441 | 16 | 331 | 17 | 235 | 13 | 130 | 6 | 115 | 5 | 301 |
| Cambridge | 153 | 1 | 215 | 1 | 321 | 1 | 400 | 1 | 420 | 1 | 476 | 1 | 482 | 1 | 464 | 1 | 367 | 1 | 251 | 1 | 164 | 1 | 124 | 1 | 322 |
| East Wa[illegible] | 140 | 13 | 218 | 13 | 305 | 12 | 385 | 14 | 452 | 14 | 508 | 14 | 493 | 14 | 436 | 14 | 365 | 14 | 258 | 14 | 163 | 14 | 140 | 14 | 322 |
| L[illegible] | 118 | 2 | 200 | 2 | 300 | 2 | 391 | 2 | 451 | 2 | 519 | 1 | 528 | 1 | 442 | 1 | 341 | 2 | 211 | 1 | 131 | 1 | 107 | 1 | 317 |
| [illegible] | 121 | 10 | 210 | 1 | 308 | 11 | 359 | 11 | 483 | 10 | 547 | 1 | 540 | 11 | 466 | 11 | 373 | 11 | 255 | 11 | 136 | 11 | 108 | 11 | 311 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 356 | [illegible] | 416 | [illegible] | 421 | 10 | [illegible] | 11 | [illegible] | 11 | 472 | 10 | 322 | 10 | 216 | 9 | 105 | 9 | 96 | [illegible] | [illegible] |
| [illegible] | 168 | 8 | 260 | 8 | 368 | 8 | 426 | 8 | 496 | 8 | 535 | 8 | 517 | 9 | 466 | 8 | 366 | 8 | 237 | 7 | 116 | 8 | 24 | 8 | 318 |
| [illegible] | 171 | [illegible] | [illegible] | [illegible] | 310 | 1 | 411 | 1 | [illegible] | 1 | 571 | 1 | [illegible] | [illegible] | 422 | [illegible] | 431 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 138 | [illegible] | 380 |
| [illegible] | 166 | [illegible] | 218 | [illegible] | 321 | [illegible] | [illegible] | [illegible] | 501 | [illegible] | [illegible] | [illegible] | 483 | [illegible] | 509 | [illegible] | 457 | [illegible] | 321 | [illegible] | 177 | | 116 | | [illegible] |
| [illegible] Glasgow | 154 | 6 | 258 | 8 | 385 | 7 | 466 | 8 | 568 | 8 | [illegible]5 | 8 | 615 | 9 | 531 | 10 | 116 | 10 | 267 | 6 | 154 | 8 | 116 | 7 | 388 |
| [illegible] Falls | 140 | 8 | 212 | [illegible] | [illegible] | [illegible] | 131 | 8 | 528 | 8 | [illegible] | 8 | [illegible] | 9 | 332 | [illegible] | 417 | 10 | 261 | [illegible] | [illegible] | | 112 | | [illegible] |
| [illegible] | 122 | 3 | 162 | 2 | 268 | 3 | 414 | 3 | 462 | 3 | [illegible] | 3 | [illegible] | 2 | 510 | 2 | 354 | 2 | 216 | 2 | 102 | 2 | 76 | 2 | [illegible] |
| [illegible] | 188 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 491 | [illegible] | 44 | 8 | 568 | 8 | 464 | 8 | [illegible] | 8 | [illegible] | [illegible] | 199 | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 3 | [illegible] | 1 | 163 | 1 | [illegible] | 1 | 318 | 3 | [illegible] | 1 | 568 | 1 | 519 | 1 | 110 | 1 | 298 | 1 | 201 | 1 | 170 | 1 | [illegible] |

| STATES AND STATIONS | JAN | YRS | FEB | YRS | MAR | YRS | APR | YRS | MAY | YRS | JUNE | YRS | JULY | YRS | AUG | YRS | SEPT | YRS | OCT | YRS | NOV | YRS | DEC | YRS | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEV Ely | 236 | 7 | 319 | 9 | 468 | 9 | 563 | 9 | 625 | 10 | 712 | 10 | 647 | 11 | 618 | 11 | 518 | 11 | 394 | 10 | 289 | 10 | 218 | 10 | 469 |
| Las Vegas | 277 | 11 | 384 | 11 | 519 | 11 | 621 | 11 | 702 | 11 | 748 | 10 | 675 | 11 | 627 | 11 | 551 | 11 | 429 | 11 | 318 | 11 | 258 | 11 | 509 |
| N J Seabrook | 157 | 8 | 227 | 8 | 318 | 8 | 403 | 8 | 482 | 9 | 527 | 8 | 509 | 8 | 455 | 9 | 385 | 9 | 278 | 7 | 192 | 8 | 140 | 8 | 339 |
| N H Mt Washington | 117 | 2 | 218 | 2 | 238 | 2 | * |  | * |  | * |  |  |  |  |  | * |  | * |  | * |  | 96 | 2 |  |
| N Mex Albuquerque | 303 | 13 | 386 | 13 | 511 | 13 | 618 | 13 | 686 | [illegible] | 726 | 13 | 683 | 12 | 626 | 13 | 554 | 14 | 438 | 13 | 334 | 13 | 276 | 13 | 512 |
| N Y Ithaca | 116 | 22 | 194 | 21 | 272 | 21 | 334 | 23 | 440 | 24 | 501 | 23 | 515 | 23 | 453 | 23 | 346 | 21 | 231 | 22 | 120 | 23 | 96 | 23 | 302 |
| N Y Central Park | 130 | 14 | 199 | 14 | 290 | 33 | 369 | 35 | 432 | 35 | 470 | 34 | 459 | 35 | 389 | 35 | 331 | 36 | 242 | 36 | 147 | 36 | 115 | 35 | 298 |
| Sayville | 160 | 11 | 249 | 11 | 335 | 10 | 415 | 10 | 494 | 10 | 565 | 10 | 543 | 10 | 462 | 10 | 385 | 10 | 289 | 10 | 186 | 10 | 142 | 11 | 352 |
| Schenectady | 130 | 8 | 200 | [illegible] | 273 | 9 | 338 | 9 | 413 | 9 | 448 | 8 | 441 | 8 | 397 | 8 | 299 | 8 | 218 | 8 | 128 | 8 | 104 | 8 | 282 |
| Upton | 155 | 8 | 212 | 8 | 319 | 8 | 428 | 8 | 502 | 8 | 573 | 8 | 543 | 7 | 475 | 7 | 391 | 7 | 293 | 6 | 182 | 7 | 146 | 7 | 355 |
| N C Greensboro | 200 | 7 | 276 | 9 | 354 | 9 | 469 | 9 | 531 | 10 | 564 | 10 | 544 | 10 | 485 | 10 | 406 | 10 | 322 | 10 | 243 | 10 | 197 | 8 | 383 |
| Hatteras | 238 | 10 | 317 | 9 | 426 | 8 | 569 | 9 | 635 | 10 | 652 | 10 | 625 | 10 | 562 | 11 | 471 | 11 | 358 | 11 | 282 | 11 | 214 | 11 | 443 |
| Raleigh | [illegible] | 3 | 302 | 2 | * |  | 466 | [illegible] | 491 | 2 | 561 | 2 | 555 | 3 | 476 | 3 | 379 | 3 | 307 | 3 | 235 | 3 | 199 | 3 |  |
| N D Bismarck | 157 | 7 | 250 | 8 | 356 | [illegible] | 447 | 8 | 550 | 8 | 590 | 9 | 617 | 10 | 516 | 11 | 390 | 11 | 272 | 11 | 161 | 10 | 124 | 10 | 369 |
| OHIO Cleveland | 125 | 9 | 183 | 6 | 303 | 7 | 286 | 8 | 502 | 8 | 562 | 8 | 562 | 8 | 494 | 8 | 278 | 8 | 289 | 9 | 141 | 9 | 115 | 7 | 335 |
| Columbus | 128 | 7 | 200 | 7 | 297 | 7 | 391 | 7 | 471 | 6 | 562 | 4 | 542 | 5 | 477 | 4 | 422 | 4 | 286 | 1 | 178 | 1 | 129 | 5 | 340 |
| Put-in-Bay | 126 | 10 | 204 | [illegible] | 302 | [illegible] | 386 | 1 | 468 | 11 | 544 | 1 | 561 | 10 | 487 | 10 | 382 | 11 | 275 | 11 | 144 | 1 | 109 | 1 | 332 |
| OKLA Oklahoma City | 251 | 10 | 319 | 9 | 409 | 9 | 494 | 10 | 546 | 10 | 615 | 7 | 610 | 8 | 590 | 8 | 487 | 9 | 377 | 10 | 291 | 9 | 240 | 9 | 436 |
| Stillwater | 205 | 8 | 289 | 8 | 390 | 9 | 454 | 9 | 504 | 9 | 600 | 10 | 596 | 10 | 545 | 10 | 455 | 11 | 354 | 10 | 269 | 9 | 209 | 8 | 405 |
| OREG Astoria | 90 | 7 | 162 | 8 | 270 | 8 | 370 | 8 | 492 | 8 | 469 | 8 | 539 | 8 | 461 | 7 | 334 | 7 | 209 | 8 | 111 | 8 | 79 | 8 | 301 |
| Corvallis | 89 | 2 | * |  | 287 | 1 | 406 | 1 | 517 | 1 | 570 | 1 | 676 | 1 | 558 | 4 | 397 | 4 | 235 | 4 | 144 | 4 | 86 | 1 |  |
| Medford | [illegible] | 1 |  |  | 356 | 1 | 482 | 1 | 592 | 1 | 652 | 1 | 658 | [illegible] | 605 | 1 | 447 | 1 | 279 | 1 | 140 | 1 | 93 | 1 | [illegible] |
| [illegible] | [illegible] |  | [illegible] |  | [illegible] | 8 | 317 |  | 429 | 1 | 491 | 5 | 497 | 7 | 409 | 8 | 335 | 8 | 207 | 5 | 118 |  | 77 | 6 | 280 |
| [illegible] | [illegible] |  | [illegible] |  | [illegible] | [illegible] | 380 | [illegible] | 436 | [illegible] | 518 | [illegible] | 511 | [illegible] | 444 | [illegible] | 358 | 10 | 256 | [illegible] | 149 |  | [illegible] | [illegible] | 318 |
| R I Newport | 155 | 21 | 232 | 22 | 334 | 23 | 405 | 23 | 477 | 24 | 527 | 24 | 513 | 24 | 455 | 24 | 377 | 24 | 271 | 24 | 176 | 4 | 139 | 24 | 338 |
| S C Charleston | 252 | 11 | 314 | 11 | 388 | 11 | 512 | 11 | 551 | 11 | 564 | 11 | 520 | 11 | 501 | 11 | 404 | 11 | 338 | 11 | 286 | 11 | 225 | 11 | 404 |
| S D Rapid City | 183 | 11 | 277 | 11 | 400 | 11 | 482 | 11 | 532 | 11 | 585 | 11 | 590 | 11 | 541 | 11 | 435 | 11 | 315 | 10 | 204 | 10 | 158 | 10 | 392 |
| TENN Nashville | 149 | 18 | 228 | 19 | 322 | 19 | 432 | 19 | 503 | 18 | 551 | 18 | 530 | 17 | 473 | 17 | 403 | 17 | 308 | 19 | 208 | 18 | 150 | 19 | 355 |
| Oak Ridge | 161 | 11 | 239 | 11 | 331 | 11 | 450 | 11 | 518 | 11 | 551 | 11 | 526 | 11 | 478 | 11 | 416 | 11 | 318 | 11 | 213 | 10 | 163 | 11 | 364 |
| TEXAS Brownsville | 297 | 1 | 341 | 1 | 402 | 1 | 456 | 11 | 564 | 10 | 610 | 9 | 627 | 8 | 568 | 11 | 475 | 11 | 411 | 11 | 296 | 11 | 263 | 1 | 442 |
| El Paso | 333 | 11 | 440 | 11 | 547 | 10 | 654 | 11 | 714 | 11 | 729 | 11 | 666 | 11 | 640 | 10 | 576 | 11 | 460 | 11 | 372 | 11 | 313 | 11 | 536 |
| Ft Worth | 250 | 11 | 320 | 11 | 427 | 11 | 488 | 11 | 562 | 11 | 651 | 11 | 613 | 11 | 593 | 11 | 503 | 11 | 403 | 11 | 306 | 11 | 245 | 9 | 445 |
| Midland | 283 | 7 | 338 | 8 | 476 | 9 | 550 | 8 | 611 | 8 | 617 | 8 | 608 | 7 | 574 | 8 | 522 | 9 | 396 | 9 | 325 | 8 | 275 | 8 | 466 |
| San Antonio | [illegible] | [illegible] | [illegible] | 8 | 417 | 9 | 445 | 9 | 541 | 9 | 612 | 9 | 619 | 9 | 565 | 9 | 493 | 10 | 398 | 10 | 295 | 10 | 256 | 8 | 442 |
| UTAH Flaming Gorge | 238 | 2 | 338 | 2 | 441 | 2 | 522 | 2 | 565 | 2 | 650 | 2 | 599 | 3 | 538 | 3 | 425 | 3 | 352 | 3 | 262 | 3 | 215 | 3 | 426 |
| Salt Lake City | 163 | 8 | 256 | 8 | 354 | 8 | 479 | 8 | 570 | 7 | 621 | 7 | 620 | 6 | 551 | 7 | 446 | 8 | 316 | 8 | 204 | 8 | 146 | 9 | 394 |
| VA Mt Weather | 172 | 2 | 274 | 2 | 338 | 2 | 414 | 2 | 508 | 2 | 525 | 3 | 510 | 3 | 430 | 3 | 375 | 3 | 281 | 2 | 202 | 2 | 168 | 2 | 350 |
| WASH North Head | * |  | 167 | 2 | 257 | 1 | 432 | 2 | 509 | 1 | 487 | 3 | 486 | 3 | 436 | 3 | 321 | 3 | 205 | 3 | 122 | 1 | 77 | 1 |  |
| Friday Harbor | 87 |  | 157 | 7 | 271 | 8 | 418 | 8 | 514 | 9 | 578 | 9 | 586 | 9 | 507 | 1 | 351 | 8 | 194 | 9 | 102 | 9 | 75 | 8 | 320 |
| Prosser | 117 | 4 | 222 | 4 | 351 | 4 | 521 | 5 | 616 | 4 | 680 | 4 | 707 | 4 | 604 | 4 | 458 | 4 | 274 | 4 | 136 | 4 | 100 | 4 | 399 |
| Pullman | 121 | 4 | 205 | 2 | 304 | 2 | 462 | 2 | 558 | 4 | 653 | 5 | [illegible] | 5 | 562 | 4 | 410 | 4 | 245 | 5 | 146 | 5 | 96 | 5 | 372 |
| University | 67 | 9 | 126 | 9 | 245 | 9 | 364 | 9 | 445 | 9 | 461 | 9 | 490 | [illegible] | 435 | 10 | 290 | 8 | 170 | 9 | 93 | 9 | 59 | 9 | 272 |
| Seattle | 75 | 9 | 139 | 9 | 265 | 9 | 403 | 9 | 503 | 9 | 511 | 9 | 566 | 9 | 452 | 10 | 324 | 9 | 168 | 9 | 94 | 9 | [illegible] | 9 | 300 |
| Spokane | 119 | 8 | 204 | 8 | 321 | 8 | 474 | 9 | 563 | 9 | 596 | 9 | 665 | 9 | 556 | 9 | 404 | 9 | 225 | 9 | 131 | 9 | 75 | 7 | 361 |
| WIS Madison | 148 | 6 | 220 | 6 | 313 | 5 | 394 | 7 | 466 | 7 | 514 | 7 | 531 | 7 | 452 | 7 | 348 | 7 | 241 | 7 | 145 | 4 | 115 | 6 | 324 |
| WYO Lander | 226 | 8 | 324 | 9 | 452 | 9 | 548 | 1 | 587 | 11 | 678 | 11 | 651 | 11 | 586 | 10 | 472 | 8 | 354 | 9 | 239 | 9 | 196 | 9 | 443 |
| Laramie | 216 | 3 | 295 | 3 | 424 | 3 | 508 | 3 | 554 | 3 | 643 | 3 | 606 | 3 | 536 | 3 | 438 | 3 | 324 | 3 | 229 | 3 | 186 | 4 | 408 |
| ISLAND STATIONS |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Canton Island | 588 | [illegible] | 626 | [illegible] | [illegible] | [illegible] | [illegible] | 9 | 561 | 9 | 549 | 8 | 550 | [illegible] | 597 | [illegible] | 640 | [illegible] | [illegible] | 9 | [illegible] | 8 | 572 | 8 | 597 |
| San Juan P R | 404 | 3 | 481 | 4 | 580 | 4 | 622 | 4 | 615 | 3 | 536 | 6 | 639 | 5 | 545 | 6 | 531 | 6 | 461 | 6 | 411 | 6 | 411 | 6 | 512 |
| Swan Island | 442 | 6 | 496 | 7 | 615 | 6 | 646 | 6 | 625 | 6 | 544 | 8 | 588 | 8 | 591 | 7 | 535 | 8 | 457 | 7 | 394 | 8 | 382 | 8 | 526 |
| Wake Island | 438 | 7 | 518 | 7 | 577 | 7 | 627 | 7 | 642 | 8 | 656 | 6 | 629 | 7 | 623 | 7 | 587 | 6 | 525 | 7 | 482 | 7 | 421 | 7 | 560 |

NOTES

* [illegible]

No data [illegible]

* [illegible]

† Maximum [illegible] after 19[illegible] used [illegible]

‡ [illegible]

[illegible]

# The Solar User's Return on His Investment

***Question.*** [illegible] of solar equipment [illegible] years? [illegible]

To answer this question [illegible]

***Future Inflation.*** Most economists expect that [illegible] a rate of at least 5 percent per year. Basically [illegible] that the [illegible] currently will appreciate over a period of time.

***Reduction in the Cost of Solar Equipment.*** [illegible] modest scale. Many of the producers of the equipment expect that as volume increases and as further product development takes place the cost of the equipment *without considering inflation* may decrease.

These two factors offset [illegible] price of a solar installation will [illegible] future [illegible] installation made today will not appreciate [illegible] inflation. (If the producers were not able to [illegible] the [illegible] equipment bought today would appreciate in value and the purchaser's return on his investment would increase correspondingly.)

***Depreciation.*** Good solar equipment should have a 20 year life. At the [illegible] percent of the useful life of the equipment would have been used up, and 40 percent would have been used up at the end of 10 years.

***Effect on Resale Value of a Residence.*** [illegible] which involves resale of [illegible] present [illegible] installed solar equipment [illegible] the resale [illegible] cost of conventional energy will rise more rapidly than the general [illegible] inflation in the future. This means that the [illegible] solar equipment [illegible] greater as [illegible] years from [illegible] will be materially better than [illegible] pages [illegible] through [illegible] attract [illegible] to the [illegible] solar equipped house [illegible] retrofitting it with solar equipment). It will always cost more to retrofit a solar system to a previously built house than to incorporate a solar system in a new house. The extra cost of retrofitting tends to become an element of appreciation [illegible] previously equipped house.

In the examples presented below we have [illegible] ignoring this element of appreciation [illegible] retrofitting an existing house would [illegible] the [illegible] installation made at the time the house was built.

***Case I*** [illegible] to the [illegible] appreciation [illegible] appreciation [illegible] $ [illegible] have saved $ [illegible] 7.5 percent per year. With [illegible] by $240. If we [illegible] on [illegible] $40 [illegible] appreciation [illegible] first 5 years [illegible] 40.6 percent.

Savings in 10 years are substantial [illegible] depreciation in 10 years is $480 [illegible] Investment in 10 years is $1,081 or 90 percent [illegible] In our figures we only deduct $336 from [illegible] Investment of $1,225 [illegible] 100 percent [illegible] If the next buyer pays the appreciated [illegible] equipped house is sold [illegible] 5 years because of the [illegible] will equal the $1,152 price [illegible] only 4 [illegible] better after 10 years. If the price he pays is the appreciated value of $861 [illegible]

[illegible]

[illegible] with the [illegible]

| | | |
|---|---|---|
| Original Cost | $50[illegible] | |
| [illegible] appreciation | $720 | |
| with appreciation | $778 | |
| [illegible]hout appreciation | $540 | |
| with appreciation | $583 | |
| Savings in 5 years | $569 | |
| Savings in 10 years | 1 382 | |
| [illegible]ation after 5 years | $389 | [illegible]) |
| with appreciation | $447 | [illegible]%) |
| [illegible] in 10 years | [illegible] | [illegible]%) |
| with appreciation | $1 [illegible]55 | [illegible]18 3%) |

[illegible]

| | |
|---|---|
| [illegible] | $[illegible] |
| [illegible] appreciation | $[illegible] |
| [illegible] appreciation | $[illegible]40 |
| with appreciation | $58[illegible] |
| [illegible] | $19[illegible] |
| [illegible] | $[illegible]19 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

[illegible]

# SOLAR SYSTEM ECONOMICS

**About Tables 1 through [illegible]**

1. They are intended [illegible] conditions in [illegible] parts of the [illegible]
2. Water heater calculations are based [illegible] typical [illegible] four
3. Space heating calculations [illegible] based [illegible] a 1,500 [illegible] square [illegible] which is of typical construction [illegible]
4. Electricity, oil and gas prices used cover the ranges [illegible] current prices. In calculating future savings it was forecast that electr[illegible] would escalate at 7.5 percent per year (5 percent inflation [illegible] 2.5 percent [illegible]) [illegible] prices were forecast to escalate at 10 percent per [illegible]
5. Pay-out time is the time required for [illegible]

Table [illegible] standard size sol[illegible]

Water heaters

| [illegible] size | [illegible] | System [illegible] |
|---|---|---|
| [illegible] | | |
| 50 ft | | |
| 75 | | |
| 100 | | 50 |
| [illegible] F | | |
| [illegible] | | |
| 50 ft | | |
| [illegible] All [illegible] | | |
| [illegible] | | |
| 50 ft | | |
| 75 | | |
| 100 | | |
| [illegible] | | |
| [illegible] | | |
| [illegible] | | |
| 75 | | |
| 100 | | |
| [illegible] | | |
| [illegible] | | |
| 50 ft | | |
| 75 | | |
| [illegible] | | |
| 50 ft | | |
| [illegible] | | |
| [illegible] | | |
| 5[illegible] | | |

| | System Cost ($) | [illegible] 40¢ Gal | 3½¢/k[illegible] 43¢ Gal | [illegible] 15¢ Gal | 15 [illegible] |
|---|---|---|---|---|---|
| **East Coast - Bo[illegible]** | | | | | |
| 40% Solar | [illegible] | | 1[illegible] | | |
| 50% Solar | 6,750 | 12[illegible] | [illegible] | [illegible] | |
| **[illegible] Coast N[illegible]** | | | | | |
| 40% Solar | | | | | |
| 50% Solar | 6,500 | [illegible] | [illegible] | [illegible] | |
| **[illegible] Coast W[illegible]** | | | | | |
| 40% Solar | | | 9[illegible] | | |
| 50% Solar | [illegible] | [illegible] | [illegible] | [illegible] | |
| **[illegible] Midwest** | | | | | |
| (Omaha [illegible] | | | | | |
| 40% Sola[illegible] | | | | | |
| 50% Sola[illegible] | | | | | |
| **[illegible] Midwest** | | | | | |
| (St Louis [illegible] | | | | | |
| 40% So[illegible] | | | | | |
| 50% Sola[illegible] | [illegible] | | | | |
| **[illegible] west** | | | | | |
| (Dallas) | | | | | |
| 40% | | | | | |
| 50% S[illegible] | | | | | |
| 60% S[illegible] | [illegible] | | | | |
| **[illegible] California** | [illegible] | | | | |
| (Los Angeles | | | | | |
| 50% Sola[illegible] | | | | | |
| 60% Sola[illegible] | | | | | |
| 70% Sola[illegible] | [illegible] | | | | |

Table 4.—The economics of solar space heating plus solar hot water heating vs. electric heat and hot water heat

| Region | Solar system cost ($) | Pay out time years (electricity) | | | |
|---|---|---|---|---|---|
| | | 3¢/kWh | 3½¢/kWh | 4¢/kWh | 5¢/kWh |
| East Coast - Boston | | | | | |
| 40% Solar | 4,875 | 10.2 | 9.1 | 8.2 | - |
| 50% Solar | 6,750 | 10.9 | 9.8 | 8.9 | - |
| East Coast - New York | | | | | |
| 40% Solar | 4,700 | 11.5 | 10.3 | 9.3 | 7.9 |
| 50% Solar | 6,800 | 12.7 | 11.4 | 10.4 | 8.8 |
| East Coast - Washington | | | | | |
| 40% Solar | 3,475 | 8.8 | 7.9 | 7.1 | - |
| 50% Solar | 5,300 | 10.2 | 9.1 | 8.3 | - |
| Upper Midwest (Omaha - Chicago) | | | | | |
| 40% Solar | 3,200 | 7.6 | 6.7 | 6.1 | - |
| 50% Solar | 4,825 | 8.8 | 7.8 | 7.0 | - |
| Lower Midwest (Nashville - St. Louis) | | | | | |
| 40% Solar | 3,275 | 9.5 | 8.5 | 7.6 | - |
| 50% Solar | 4,825 | 10.7 | 9.6 | 8.6 | - |
| Southwest (Dallas) | | | | | |
| 40% Solar | 2,200 | 8.2 | 7.3 | 6.6 | - |
| 50% Solar | 3,000 | 8.7 | 7.8 | 7.0 | - |
| 60% Solar | 4,875 | 10.9 | 9.8 | 7.8 | - |
| Southern California (Los Angeles) | | | | | |
| 50% Solar | 1,500 | 5.7 | 5.0 | 4.5 | - |
| 60% Solar | 2,175 | 6.7 | 5.9 | 5.3 | - |
| 70% Solar | 3,000 | 7.6 | 6.7 | 6.0 | - |

Table 5.—The economics of solar space heating plus solar hot water heating vs. natural gas heat plus hot water heat

| Region | Solar system cost ($) | Pay out time, years (gas) | | | |
|---|---|---|---|---|---|
| | | 12.5¢/therm | 15¢/therm | 17.5¢/therm | 20¢/therm |
| East Coast - Boston | | | | | |
| 40% Solar | 4,875 | 20.5 | 18.9 | 17.6 | 16.5 |
| 50% Solar | 6,750 | 21.5 | 19.8 | 18.5 | 17.3 |
| East Coast - New York | | | | | |
| 40% Solar | 4,700 | 22.1 | 20.5 | 19.1 | 17.9 |
| 50% Solar | 6,800 | 23.5 | 21.8 | 20.4 | 19.2 |
| East Coast - Washington | | | | | |
| 40% Solar | 3,475 | 18.8 | 17.3 | 16.0 | 14.9 |
| 50% Solar | 5,300 | 20.6 | 19.0 | 17.6 | 16.5 |
| Upper Midwest (Omaha - Chicago) | | | | | |
| 40% Solar | 3,200 | 17.1 | 15.6 | 14.4 | 13.4 |
| 50% Solar | 4,825 | 18.8 | 17.2 | 15.9 | 14.8 |
| Lower Midwest (Nashville - St. Louis) | | | | | |
| 40% Solar | 3,275 | 19.7 | 18.1 | 16.8 | 15.7 |
| 50% | 4,825 | 21.2 | 19.5 | 18.2 | [illegible] |
| Southwest (Dallas) | | | | | |
| 40% Solar | 2,200 | 18.0 | 16.4 | 15.2 | 14.1 |
| 50% Solar | 3,000 | 18.7 | 17.2 | 15.9 | 14.8 |
| 60% Solar | 4,875 | 21.4 | 19.8 | 18.4 | 17.3 |
| Southern California (Los Angeles) | | | | | |
| 50% Solar | 1,500 | 14.2 | 12.8 | [illegible] | [illegible] |
| 60% Solar | 2,175 | [illegible] | 14.3 | [illegible] | [illegible] |
| 70% Solar | 3,000 | [illegible] | 15.6 | [illegible] | [illegible] |

Table 6.—Heat values of fuels and electricity

| Product | Btu | Unit |
|---|---|---|
| Anthracite | 25,400,000 | ton |
| Bituminous | 26,200,000 | ton |
| Coke | 24,800,000 | ton |
| Natural gas (Dry) | 103,500 | Cft |
| Butane | 102,000 | gallon |
| Propane | 91,500 | gallon |
| Crude oil | 5,800,000 | barrel |
| Diesel fuel | 138,238 | gallon |
| Distillate fuel oil | 138,690 | gallon |
| Gasoline | 125,071 | gallon |
| Jet fuel | 135,000 | gallon |
| Kerosene | 135,000 | gallon |
| Electricity | 3,412 | kWh |

## Table 7.—Conversion factors

| Product | Btu | Unit |
|---|---|---|
| Coal: | | |
| Anthracite (Penn.) | 25,400,000 | Ton |
| Bituminous | 26,200,000 | Ton |
| Blast furnace gas | 100 | ft³ |
| Briquettes and package fuels | 28,000,000 | Ton |
| Coke | 24,800,000 | Ton |
| Coke breeze | 20,000,000 | Ton |
| Coke-oven gas | 550 | ft³ |
| Coal tar | 150,000 | gallon |
| Coke-oven and manufactured gas products, light oils | 5,460,000 | barrel |
| Natural gas (dry) | 1,035 | ft³ |
| Natural gas liquids (average) | 4,011,000 | barrel |
| Butane | 4,284,000 | barrel |
| Propane | 3,843,000 | barrel |
| Petroleum: | | |
| Asphalt | 6,640 000 | barrel |
| Coke | 6,024 000 | barrel |
| Crude Oil | 5,800,000 | barrel |
| Diesel | 5,806 000 | barrel |
| Distillate fuel oil | 5,825,000 | barrel |
| Gasoline, aviation | 5 048 000 | barrel |
| Gasoline, motor fuel | 5 253 000 | barrel |
| Jet fuel | | |
| Commercial | 5 670,000 | barrel |
| Military | 5,355,000 | barrel |
| Kerosene | 5 670 000 | barrel |
| Lubricants | 6 060 000 | barrel |
| Miscellaneous oils | 5 588 000 | barrel |
| Refinery still gas | 5 600 000 | barrel |
| Heavy fuel oil | 6 287 000 | barrel |
| Road oils | 6 640 000 | barrel |
| Wax | 5 570 000 | barrel |
| Electricity | 3,412 | kWh |

## DOLLAR SAVINGS AND PAYOFF PERIOD FOR HEATING INSTALLATION* 2,000 SQ. FT. HOME – ELECTRIC HEAT

| ENERGY COSTS | AVERAGE YEARLY EFFICIENCY OF SYSTEM | $ SAVED PER COLLECTOR PER YEAR | % YEARLY RETURN | PAYBACK PERIOD (YEARS) (100% OF INSTALLED COST CHARGED AGAINST SAVINGS) | ADJUSTED PAYBACK PERIOD (YEARS) (33% VALUE OF SYSTEM ADDED TO STRUCTURE) |
|---|---|---|---|---|---|
| *LOW SOLAR RADIATION* | | | | | |
| $.03/kW | 60 | 35.00 | 11.2 | 9.0 | 5.9 |
| | 50 | 29.07 | 9.3 | 10.7 | 7.1 |
| | 40 | 23.19 | 7.4 | 13.8 | 9.0 |
| $.05/kW | 60 | 58.00 | 18.6 | 5.3 | 3.6 |
| | 50 | 48.20 | 16.4 | 6.0 | 4.0 |
| | 40 | 38.60 | 12.3 | 8.2 | 5.4 |
| *MEDIUM SOLAR RADIATION* | | | | | |
| $.03/kW | 60 | 46.20 | 14.8 | 6.7 | 4.5 |
| | 50 | 38.70 | 12.4 | 8.1 | 5.4 |
| | 40 | 30.86 | 9.9 | 10.3 | 6.5 |
| $.05/kW | 60 | 77.10 | 24.7 | 4.0 | 2.7 |
| | 50 | 64.50 | 20.7 | 4.8 | 3.2 |
| | 40 | 51.80 | 16.6 | 6.0 | 4.0 |
| *HIGH SOLAR RADIATION* | | | | | |
| $.03/kW | 60 | 58.00 | 18.6 | 5.3 | 3.6 |
| | 50 | 48.30 | 15.5 | 6.4 | 3.1 |
| | 40 | 38.60 | 12.4 | 8.1 | 3.6 |
| $.05/kW | 60 | 97.00 | 31.1 | 3.0 | 2.1 |
| | 50 | 80.80 | 26.1 | 4.0 | 2.6 |
| | 40 | 64.80 | 20.7 | 4.8 | 3.2 |

*At total installed system cost of $16.00/sq. ft.

**DOLLAR SAVINGS AND PAYOFF PERIOD FOR HEATING INSTALLATION*    2,000 SQ. FT. HOME — OIL HEAT**

| ENERGY COSTS | AVERAGE YEARLY EFFICIENCY OF SYSTEM | $ SAVED PER COLLECTOR PER YEAR | % YEARLY RETURN | PAYBACK PERIOD (YEARS) (100% OF INSTALLED COST CHARGED AGAINST SAVINGS) | ADJUSTED PAYBACK PERIOD (YEARS) (33% VALUE OF SYSTEM ADDED TO STRUCTURE) |
|---|---|---|---|---|---|
| *LOW SOLAR RADIATION* | | | | | |
| $.40/Gal. | 60 | 17.37 | 5.6 | 17.9 | 11.7 |
| | 50 | 14.56 | 4.7 | 21.3 | 14.1 |
| | 40 | 11.60 | 3.8 | 26.3 | 13.8 |
| $.55/Gal. | 60 | 23.94 | 7.2 | 13.9 | 8.7 |
| | 50 | 19.90 | 6.4 | 15.6 | 10.4 |
| | 40 | 15.90 | 5.1 | 19.6 | 13.0 |
| $.70/Gal. | 60 | 30.39 | 9.8 | 10.2 | 6.8 |
| | 50 | 25.40 | 8.2 | 12.2 | 8.1 |
| | 40 | 20.20 | 6.5 | 15.4 | 10.2 |
| *MEDIUM SOLAR RADIATION* | | | | | |
| $.40/Gal. | 60 | 23.15 | 7.4 | 13.5 | 8.8 |
| | 50 | 19.40 | 6.2 | 16.0 | 10.7 |
| | 40 | 15.50 | 5.0 | 20.0 | 13.3 |
| $.55/Gal. | 60 | 31.95 | 10.3 | 9.7 | 6.6 |
| | 50 | 26.50 | 8.5 | 11.8 | 7.9 |
| | 40 | 21.20 | 6.8 | 14.7 | 9.8 |
| $.70/Gal. | 60 | 40.55 | 13.0 | 7.7 | 5.1 |
| | 50 | 33.80 | 10.8 | 9.3 | 6.1 |
| | 40 | 27.10 | 8.7 | 11.5 | 7.6 |
| *HIGH SOLAR RADIATION* | | | | | |
| $.40/Gal. | 60 | 29.10 | 9.3 | 12.3 | 7.2 |
| | 50 | 24.20 | 7.8 | 14.6 | 8.5 |
| | 40 | 19.30 | 6.2 | 18.5 | 10.7 |
| $.55/Gal | 60 | 39.90 | 12.7 | 9.0 | 9.4 |
| | 50 | 33.30 | 10.7 | 10.7 | 6.3 |
| | 40 | 26.60 | 8.5 | 13.4 | 7.8 |
| $.70/Gal | 60 | 50.80 | 16.2 | 7.0 | 4.1 |
| | 50 | 42.30 | 13.6 | 8.4 | 4.9 |
| | 40 | 33.80 | 10.8 | 10.6 | 6.2 |

*At total installed system cost of $16.00/sq. ft.

## DOLLAR SAVINGS AND PAYOFF PERIOD FOR HEATING INSTALLATION* 2,000 SQ. FT. HOME — GAS HEAT

| ENERGY COSTS | AVERAGE YEARLY EFFICIENCY OF SYSTEM | $ SAVED PER COLLECTOR PER YEAR | % YEARLY RETURN | PAYBACK PERIOD (YEARS) (100% OF INSTALLED COST CHARGED AGAINST SAVINGS) | ADJUSTED PAYBACK PERIOD (YEARS) (33% VALUE OF SYSTEM ADDED TO STRUCTURE) |
|---|---|---|---|---|---|
| *LOW SOLAR RADIATION* | | | | | |
| $.18/CCF | 60 | 9.80 | 3.2 | 31.2 | 20.8 |
| | 50 | 8.17 | 2.6 | 38.5 | 25.6 |
| | 40 | 6.54 | 2.1 | 47.6 | 31.2 |
| $.34/CCF | 60 | 18.45 | 5.9 | 17.0 | 11.2 |
| | 50 | 15.35 | 5.0 | 20.0 | 13.3 |
| | 40 | 12.30 | 4.0 | 25.0 | 16.7 |
| $.45/CCF | 60 | 24.50 | 7.8 | 12.8 | 8.5 |
| | 50 | 20.40 | 5.5 | 18.2 | 12.5 |
| | 40 | 16.33 | 4.2 | 23.8 | 15.9 |
| *MEDIUM SOLAR RADIATION* | | | | | |
| $.18/CCF | 60 | 13.10 | 4.2 | 23.8 | 15.8 |
| | 50 | 10.90 | 3.5 | 28.5 | 18.8 |
| | 40 | 8.70 | 2.8 | 35.7 | 23.8 |
| $.34/CCF | 60 | 24.70 | 7.9 | 12.6 | 8.4 |
| | 50 | 20.60 | 6.6 | 15.1 | 10.0 |
| | 40 | 16.40 | 5.3 | 18.8 | 12.6 |
| $.45/CCF | 60 | 32.70 | 10.5 | 9.5 | 6.4 |
| | 50 | 22.70 | 7.3 | 13.7 | 9.2 |
| | 40 | 17.60 | 5.6 | 17.8 | 11.9 |
| *HIGH SOLAR RADIATION* | | | | | |
| $.18/CCF | 60 | 16.25 | 5.2 | 19.2 | 12.8 |
| | 50 | 13.50 | 4.4 | 22.7 | 15.1 |
| | 40 | 10.90 | 3.5 | 28.6 | 18.9 |
| $.34/CCF | 60 | 30.70 | 9.9 | 10.0 | 6.7 |
| | 50 | 25.60 | 8.2 | 12.2 | 8.1 |
| | 40 | 20.40 | 6.6 | 15.2 | 10.1 |
| $.45/CCF | 60 | 40.70 | 13.1 | 7.6 | 5.1 |
| | 50 | 28.20 | 9.1 | 11.0 | 7.3 |
| | 40 | 21.80 | 7.0 | 14.3 | 9.5 |

*At total installed system cost of $16.00/sq. ft

May 30, 1975

Dear

The evaluation of your home's solar heating and energy conservation potential is complete and a synopsis of the results is given below. A detailed analysis is enclosed in the work sheets attached to this letter. In our analysis, the projected cost of electrical energy was used to determine how much solar energy and improved insulation would save you over a fifteen-year period. This cost savings was used to select an optimum system for you. However, projecting energy costs is risky because the effects of oil embargoes or of the President placing taxes on oil cannot be accurately determined. The projection data that we use was taken from a government report and probably underestimates future energy costs. Therefore, (company) expects you to save more than the amount we have stated in this evaluation.

The following is a synopsis of the evaluation results:

1. Your present home requires 38,500 Btu/degree day* for home heating and domestic hot water. This presently costs you $1200 per year. In fifteen years, based on projected energy costs, you would spend $2200 per year for the same. Accumulating all the yearly costs ofer a fifteen-year period, you would spend $26,257 to heat your home and hot water.

2. Your home insulation can be improved which will lower your annual heating bill. (Company) recommends the addition of storm windows and doors, insulating the hot air ducts and adding an additional three inches of insulation in the ceiling. Although you presently have thermopane windows and doors, storm doors and windows would reduce infiltration losses. These insulation improvements would lower your heating load by 21% and save you $251 per year at present energy costs. Using projected energy costs, over the course of fifteen years, these insulation improvements would save you $5492.08.

3. An operational schematic of the solar heating system is attached. It uses water as the heat transfer media and will provide domestic hot water as well as home heat. In the summer, excess solar heat not needed to heat the domestic water could be used to heat the swimming pool.

4. Two solar heating system sizes were optimal. The solar heating system (company) recommends would have a solar collector area of 500 square feet, and would be mounted on modules in your backyard. Since your home faces 41 degrees away from south, solar collector placement on your roof was unadvisable. A diagram of this system, shown with the proposed swimming pool, is also attached. (Company) recommends this solar heating system be considered only in conjunction with the improved insulation package.

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*A degree-day is an engineering measure of the amount of heat your home requires based on local weather data. A Btu is a unit of heat.

5. The other solar heating system optimized has an area of 800 square feet. However, since a larger system is more costly, and the recommended system is mounted on modules, additional collector area could be added to the recommended system at a later date.

6. The recommended 500 square feet system would supply 35% of the yearly heating load of the recommended better insulated home. This system (recommended system No. 3 of the work sheets) would, in combination with the insulation package, save you $608 per year, or over half of what you are presently paying. Usine projected energy costs, this solar heat and insulation package would save you $13,288 over the course of fifteen years.

7. The solar heating system is estimated to cost $20 per square foot yielding a cost of $10,000. The insulation improvements are estimated to cost $2,000. The total package cost is estimated to be $12,000, and should pay for itself in about thirteen years. A firm fixed price for the package would be quoted when a solar heating installation contract is negotiated. If you install the system yourself, (company) supplying plans, technical advice and materials, the solar heating system cost could be reduced to $6,500.

8. The excess solar heat obtained in the summer months can be used to heat your pool at a savings of $290 per summer at present energy costs. Using projected energy costs, over the course of fifteen years, the excess solar heat would save you an additional $6,300. This excess solar heat, in combination with a pool cover, which (company) recommends, would raise the pool water temperature 7 degrees over that of an unheated, uncovered pool.

The following table lists our recommendations, their costs, and your expected savings.

| RECOMMENDATION | ESTIMATED COST | PROJECTED SAVINGS OVER FIFTEEN YEARS |
|---|---|---|
| Insulation Package | $ 2,000 | $ 5,492 |
| 500-square-foot solar heating | 10,000 | 13,288<br>(includes insulation) |
| Solar pool heat | -0- | 6,300 |
| Total | 12,000 | 19,588 |

If you have any questions about this evaluation, please feel free to contact us.

Sincerely,

Enclosures:
(1) Work Sheets
(2) Operational Schematic
(3) Collector Array Diagram
(4) Solar Profile

## Solar Heating Potential Survey

DATE: May 30, 1975
NAME:
ADDRESS:

SURVEYORS (S):

SURVEY INFORMATION ATTACHED: yes

### PRESENT HEATING LOADS AND REQUIREMENTS

| DOMESTIC HOT WATER | LOAD | PRESENT ESTIMATED COST |
|---|---|---|
| MINIMUM | 440 kWh/mo | $15.00/mo |
| MAXIMUM | 880 kWh/mo | 30.00/mo |

PRESENT HOME HEATING REQUIREMENTS:

HEATING BILLS: Analysis of your home heating bills in conjunction with local weather data yields a home heating load of 38,500 Btu/degree-day.

CONSTRUCTION DETAILS (Drawings available):

| ITEM | AREA (ft²) | NOTES |
|---|---|---|
| CEILING | 2,718 | 6" insulation |
| CEILING (other) | 0 | |
| WALLS (exposed to dirt) | 200 | block |
| WALLS (exposed to air) | 1,936 | 3.62" insulation |
| WALLS (to unheated space) | 0 | |
| WALLS (other) | 435 | block to air |
| WINDOWS AND S.G. DOORS | 400 | thermopane |
| WINDOWS (other) | 13 | skylight |
| FLOOR (crawl space) | 560 | 6" insulation |
| FLOOR (unheated space) | 644 | |
| FLOOR (dirt) | 2,592 | |
| FLOOR (other) | 0 | |
| ADDITIONAL | 0 | |

Analysis of your home construction details yields a home heating load of 39,950 Btu/degree-day

HOME HEATING LOAD USED IN THIS EVALUATION 38,500 Btu/degree-day

ESTIMATED YEARLY HEATING LOAD INCLUDING HOME HEAT AND DOMESTIC HOT WATER

| Btu/year | kWh/year | Present cost |
|---|---|---|
| $211 \times 10^6$ | $61.8 \times 10$ | $1,200.00 |

PRESENT COST OF HEATING ENERGY: $0.02/kWh

INSULATION EVALUATION

WINDOWS: Add storm windows to reduce infiltration losses

SAVINGS: Reduce heat load by 6 percent

COST:

DOORS: Add storm doors to reduce infiltration losses

SAVINGS: Reduce heat losses by 7 percent

COST:

FLOORS: None

SAVINGS:

COST:

CEILING: Increase insulation thickness from 6 inches to 9 inches

SAVINGS: Reduce heat load by 2 percent

COST:

WALLS: None

SAVINGS:

COST:

OTHER: Insulate exposed air ducts with 3.5 inches insulation

SAVINGS: 10 percent

COST:

INSULATION IMPROVEMENT EFFECT ON PRESENT YEARLY HEATING LOAD

| PRESENT HEAT LOAD | IMPROVED HEAT LOAD | IMPROVED HEATING COST | YEARLY SAVINGS USING PRESENT ENERGY COSTS |
|---|---|---|---|
| 61,800 kWh/yr | 47,400 kWh/yr | $949.00/yr | $251.00/yr |

TOTAL COST OF INSULATION IMPROVEMENT RECOMMENDATIONS:

## SOLAR HEATING SYSTEM APPLIED TO YOUR HOME

| | |
|---|---|
| LOCATION OF THE SOLAR COLLECTOR ARRAY: | The best and easiest to install location for the solar collectors would be in the backyard. A diagram of this array, shown together with the proposed swimming pool is included in this evaluation. |
| LOCATION OF THE STORAGE TANK. | The heat storage tank would best be located inside the structure which holds the solar collector array. |
| OTHER CONSIDERATIONS | This evaluation will also consider the solar heating impact on a proposed swimming pool. |

## Solar Heating System

RECOMMENDED SYSTEM #1

COLLECTOR AREA: 800 square feet — LOCATION: Backyar

ORIENTATION: See diagram — TILT ANGLE: 55 degree

STORAGE TANK SIZE: 1200 gallons

STORAGE TANK LOCATION: Backyard

### System Performance Details

| MONTH | PRESENT HOME HEAT LOAD/MO (Million Btu) | HEAT SUPPLIED BY RECOMMENDED SOLAR HEATING SYSTEM (Million Btu/mo) | PERCENT SOLAR HEAT | EXCESS HEAT (FOR POOL) (Million Btu/mo) |
|---|---|---|---|---|
| JAN | 40.8 | 8.2 | 20 | - |
| FEB | 35.0 | 9.0 | 25.7 | - |
| MAR | 29.2 | 11.5 | 39.3 | - |
| APR | 15.2 | 12.3 | 80.9 | - |
| MAY | 6.6 | 6.6 | 100 | 7.7 |
| JUN | 1.7 | 1.7 | 100 | 13.6 |
| JUL | 1.6 | 1.6 | 100 | 15.1 |
| AUG | 1.6 | 1.6 | 100 | 16.3 |
| SEP | 3.2 | 3.2 | 100 | 13.0 |
| OCT | 12.8 | 12.8 | 100 | 2.8 |
| NOV | 24.9 | 10.6 | 42.5 | - |
| DEC | 38.5 | 7.7 | 20 | - |
| TOTAL | 211.1 | 86.8 | | |

PRESENT YEARLY HEATING BILL SAVINGS FOR ABOVE SYSTEM USING PRESENT ENERGY COSTS $488.00

PROJECTED YEARLY HEATING COSTS WITH AND WITHOUT SOLAR HEAT

| TIME | PRESENT HOME HEATING COSTS NO SOLAR HEAT $/YR | PRESENT HOME HEATING COSTS W/SOLAR HEAT $/YR | PROJECTED YEARLY SAVINGS |
|---|---|---|---|
| PRESENT | 1,200 | 712 | 488 |
| IN 5 YEARS | 1,532 | 910 | 622 |
| IN 10 YEARS | 1,866 | 1,108 | 758 |
| IN 15 YEARS | 2,198 | 1,305 | 893 |
| ACCUMULATED COSTS AND SAVINGS | 26,257 | 15,596 | 10,668 |

ESTIMATED* COST OF INSTALLING SOLAR HEATING SYSTEM $20.00/ft² $16,000.00

NOTE This system would take about 20 years to pay for itself

* The cost of solar heating system is only an estimate used in this evaluation. Although the estimate should not change by much a firm fixed price would be quoted when a solar heating installation contract is negotiated

RECOMMENDED SYSTEM #2

COLLECTOR AREA: 800 square feet LOCATION: Backyard

ORIENTATION: see diagram TILT ANGLE: 55 degrees

STORAGE TANK SIZE: 1200 gallons

STORAGE TANK LOCATION: Backyard

OTHER CONSIDERATIONS: Assume home to be insulated to above recommendations. Home heating load reduced to 47,400 kWh/yr.

PERCENT OF YEARLY HEATING BILL SUPPLIED BY ABOVE SOLAR HEATING SYSTEM: 52.7 percent for insulated home above, based on 47,400 kWh/yr usage.

## PROJECTED YEARLY HEATING COSTS FOR UPGRADED INSULATION HOME WITH AN 800-SQUARE FOOT SOLAR HEATING SYSTEM

| Time | Present home, present insulation no solar $/yr | Insulated home with solar heat $/yr | Projected yearly savings $/yr |
|---|---|---|---|
| Present | 1,200 | 448 | 752 |
| In 5 years | 1,532 | 549 | 983 |
| In 10 years | 1,866 | 696 | 1,170 |
| In 15 years | 2,198 | 820 | 1,378 |
| Accumulated costs and savings in 15 years | 26 257 | 9,516 | 16 731 |

ESTIMATED COST OF INSTALLING SOLAR HEATING SYSTEM \$20/ft$^2$ plus \$2,000 for insulation = \$18,000

NOTE: This system would pay for itself in about 16 years

*The cost of solar heating system is only an estimate used in this evaluation. Although the estimate should not change by much, a firm fixed price would be quoted when a solar heating installation contract is negotiated

[illegible]

legislation [illegible]
taken from a government report and [illegible]
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trees we [illegible]

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[illegible] this [illegible] attributable [illegible] the [illegible]

| | | |
|---|---|---|
| [illegible] | | [illegible] |
| Frame 2 | [illegible] | [illegible] |
| Frame 2 | 4 [illegible] | [illegible] |
| Frame 2 | 6 [illegible] | [illegible] |
| Frame 2 | 6 [illegible] | [illegible] |
| Block 1 | | [illegible] |
| Block 1 | | [illegible] |
| Block 3 | [illegible] | [illegible] |
| Block 3 | [illegible] | 10 |
| Block 3 | [illegible] | [illegible] |
| [illegible] | [illegible] | |
| [illegible] | [illegible] | |
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| | | | |
|---|---|---|---|
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| [illegible] | | [illegible] | [illegible] |

850

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Nov | [illegible] | [illegible] | 2 0[illegible] | 5 17 | 350 |
| Dec | [illegible] | [illegible] | 2 0[illegible] | 4 3[illegible] | [illegible] 293 |

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[illegible] age t [illegible]

| [illegible] | [illegible] | |
|---|---|---|
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| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | 1 [illegible] | [illegible] |
| 2 [illegible] | 1 50 | [illegible] |
| 2 [illegible] | 1 30 | [illegible] |
| 2 [illegible] | [illegible] | [illegible]4 |
| [illegible] 07 | [illegible] | [illegible] |
| 07 | 6 [illegible] | [illegible] |

| Sys. size | Btu per | | Estimated savings |
|---|---|---|---|
| Hot | | | |
| Hea | | | |
| Total | [illegible] | | |
| | 55% | | |
| 150 | | | |
| Hot | | | |
| Hea | | | |
| Tot | | | |
| 200 | | | |
| Hot | | | |
| Hea | | | |
| Tot | | | |
| Hot | | | |
| Heat | | | |
| Total | [illegible] | | |
| 250 | | | |
| Hot | | | |
| Hea | | 600 | |
| Tot | [illegible] | 600 | |
| | [illegible] | | |

[illegible] heating [illegible] energy [illegible] systems) would [illegible] you [illegible] selecting an optim[illegible] system for y[illegible] the effects of oil [illegible]bargoes or Pre[illegible] projection data that we used was [illegible] estimates future energy costs [Company] [illegible] we have stated in this evaluation. Throughout this rep[illegible] we [illegible] inflation rate of 7%

[illegible] to the payback period (the [illegible] operating [illegible] essentially free). [illegible] determine the effect of energy conservation [illegible] installation.

[illegible]

1. HEATING REQUIREMENTS

Your home requires 22,636 k[illegible] domestic hot water heating. During the present [illegible] you $905. In fifteen years based on projected [illegible] $2,527 for the same energy. Accumulating all [illegible] you would spend $20,257 to heat your home and hot water.

INSULATION EVALUATION

The insulation in your home [illegible] and heat your basement [illegible] wall insulation. One type of installation [illegible] with paneling [illegible] basement is presently [illegible] effect of basement insulation on your present heating requirements was not included in this evaluation.

ENERGY CONSERVATION IMPROVEMENTS HEAT PUMPS

The effect of an electric heat pump on your yearly heating bill was [illegible]. A heat pump can reduce your space heating requirement [illegible] requirements by approximately 30% in the Washington, D.C. area. This would reduce the yearly total heating bill from $903 to $68[illegible] yearly savings of $216 [illegible] heat pump [illegible] savings of $475 [illegible] fifteen years. An installed heat pump [illegible] estimated to cost $2,[illegible] and would require 8 years to pay back its initial [illegible] heat pump [illegible] Then [illegible] higher [illegible] pump [illegible].

[illegible] company did not estimate [illegible] not recommend the hybrid system at this time.

SOLAR HEATING SYSTEMS

Two solar heating systems were [illegible] both your home and domestic hot water [illegible] domestic hot water. Both systems would [illegible] your south facing roof and store energy in a [illegible] basement.

[illegible]

It would reduce your present [illegible] save you $407 a year. Based on projected [illegible] the system would save you $10,[illegible]24 over the course of fifteen years. This system [illegible] cost $8,000 and would require 12¼ years to pay for itself.

## B. SOLAR DOMESTIC HOT WATER HEATING SYSTEM [illegible]

[illegible] solar heating system considered for your home would heat only [illegible] domestic hot water. For this system [company] recommends [illegible] collector with an area of 100 square feet and a storage tank [illegible] gallons. This system would supply 85 [illegible] estimated [illegible] needs. Your average hot water requirements were estimated to be [illegible] gallons per day. Since you presently paid approximately $177 per [illegible] domestic hot water, this system would presently save you $1[illegible] per [illegible] fifteen [illegible] this system would save you $[illegible]89 per [illegible] energy [illegible] this system would save you $3,793 over the [illegible] years. A solar heated [illegible] hot water [illegible] would cost [illegible] $2[illegible] and would require 9[illegible] years to pay for itself. This system would [illegible] so that it could be expanded into System "A" at a future [illegible]

## C. SOLAR HEATED POOL [illegible]

[illegible] solar heat [illegible] system (40[illegible] square feet of collector [illegible] This excess solar [illegible] requirements for high [illegible] temperature [illegible] 6 degrees [illegible] presently save you $[illegible] per year at present [illegible] over the [illegible] of fifteen years the solar [illegible] heater would save [illegible] $5,[illegible]

[illegible]

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[illegible] install the solar space heating system. Part of the [illegible] plumbing, controls, etc. [illegible] also needed for the space heating system [illegible] exist. The relatively inexpensive solar heated domestic hot water system would give you complete exposure to the potential of solar energy and would allow [illegible] flexibility of installing a heat pump with [illegible] was [illegible] capital

# Solar Heating Potential Survey

SURVE[illegible]

FLOOR ([illegible]
FLOOR ([illegible]
FLOOR ([illegible]
FLOOR ([illegible]
ADDITION[illegible]

[illegible] FLOORS

[illegible] degrees [illegible]

[illegible] than [illegible]

RIENTA [illegible]

TORAGE TAN [illegible]

STORAGE TANK [illegible]

NOTE [illegible]

The [illegible]

[illegible] contact is ne [illegible]

## Solar Heating System

[illegible]

STORAGE TANK SIZE 30[illegible]

STORAGE TANK LOCATION [illegible]

[illegible]

## Solar Heating System